10050990

Arkwright Dump Site
Spartanburg, Spartanburg County, South Carolina

RECORD OF DECISION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

U.S.Environmental Protection Agency - Region IV
Atlanta, Georgia
September 2002

PART 1: DECLARATION

A. SITE NAME AND LOCATION

Arkwright Dump Site
CERCLIS ID No. SC0 002 333 229
Spartanburg, Spartanburg County, South Carolina

B. STATEMENT OF BASIS AND PURPOSE

This decision document presents the Selected Remedy for the Arkwright Dump Site, a municipal landfill in Spartanburg, Spartanburg County, South Carolina, which was chosen in accordance with CERCLA, as amended by SARA, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan. This decision is based on the Administrative Record for this Site.

C. ASSESSMENT OF THE SITE

The response action selected in this Record of Decision is necessary to protect the public health, welfare, or the environment from actual or threatened releases of hazardous substances into the environment from this Site.

D. DESCRIPTION OF THE SELECTED REMEDY

The selected remedy employs the Presumptive Remedy for CERCLA municipal landfills (containment) as one of four (4) major components, which are briefly listed below:

- Construction / Installation of a Flexible Membrane Liner (FML) Cap:
  The landfill area will be capped in accordance with the Federal and State ARARs for solid waste landfills, with long-term O&M of the cap. Waste will be moved and consolidated as necessary to bring the contents to within the boundaries shown in the Feasibility Study (ROD Figure I-1). The cap will consist of native soils compacted to the required permeability (1×10^{-5} cm/sec), with a liner (FML) installed over the compacted soil. The liner will then be covered with soil and a vegetative cover (root zone) will be constructed on the exterior. The cap includes passive gas venting and appropriate surface-water runoff controls.

- Implementation of Enhanced Biodegradation treatment for groundwater contamination:
  Enhanced Biodegradation treatments will be performed on groundwater to enhance or accelerate microbial degradation / destruction of Site COCs. A Treatability Study will be conducted to determine the most effective delivery strategies and gather necessary design information. One or more similar process

options such as injection of HRC, molasses, vegetable oil, or others may be used. Unless determined otherwise in the Treatability Study, the treatment will be targeted on those areas around the toe of the landfill that were found in the RI to be significant sources of contaminants leaching to groundwater.

- Institutional Controls:

  Institutional controls will be necessary to prevent exposure to Site soils, since physical access to the Site is unrestricted and the cap will require 12-15 months to install. Controls may include easements, covenants, or possibly deed notices. Similarly, institutional controls to restrict the use of groundwater may be necessary on adjoining properties underlain by offsite-migrating groundwater containing Site Chemicals of Concern (COCs). Since land uses on and near the Site are undecided, an Institutional Controls Plan will be prepared during Remedial Design to ensure that Site use remains consistent with the remedy.

- Groundwater Monitoring:

  Groundwater monitoring for Site Contaminants of Concern will be performed during the Remedial Design and Remedial Action phases, to monitor groundwater conditions before and after cap installation, and monitor the progress of treatment.

E. <u>STATUTORY DETERMINATIONS</u>

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

Since this is a Presumptive Remedy (CERCLA landfill) site, direct treatment or removal of the source materials in the landfill is not feasible. Therefore, under the Presumptive Remedy, the preference for treatment of wastes, rather than containment, cannot reasonably be met.

This remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that would allow for unlimited use and unrestricted exposure. Use of the Site will always be restricted to the degree necessary to maintain the cap and assure its integrity. Therefore, an initial statutory Five-Year Review will be conducted five (5) years after Remedial Action construction begins, and additional reviews will be conducted every five years in accordance with the NCP.

F. DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this Record of Decision. Additional information can be found in the Administrative Record file for this Site.

- ☐ Chemicals of concern (COC) and their respective concentrations.
- ☐ Baseline risk represented by the COCs.
- ☐ Cleanup levels established for COCs and the basis for the levels.
- ☐ How source materials constituting principal threats are addressed.
- ☐ Current and reasonably anticipated future land use assumptions and current and future beneficial uses of groundwater considered in the baseline risk assessment and ROD.
- ☐ Potential land and groundwater use that will be available at the Site as a result of the Selected Remedy.
- ☐ Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected.
- ☐ Key factors that led to selecting the remedy.

G. AUTHORIZING SIGNATURE

Richard D. Green   30 SEP 02

Richard D. Green
Director
Waste Management Division
Region IV
United States Environmental Protection Agency

Date: 30 SEP 02

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

PART II: DECISION SUMMARY

A. SITE NAME, LOCATION, AND DESCRIPTION

A.1 Site Identification and Location

The Arkwright Dump Site has been assigned US EPA ID Number SC0 002 333 229. The Site is an abandoned landfill located just south of the city limits of Spartanburg, in Spartanburg County, South Carolina (Figure A-1). The geographical coordinates are latitude N 34 deg 55 min 04 sec, longitude W 81 deg 55 min 14.2 sec.

A.2 Site Type

The Site is a 30-acre abandoned landfill. It was operated in the 1950s and 1960s by the City of Spartanburg.

A.3 Lead and Support Agencies

US EPA Region 4 has served in the lead agency role for all CERCLA activities to date. The South Carolina Department of Health and Environmental Control, Office of Environmental Quality Control, is the support agency.

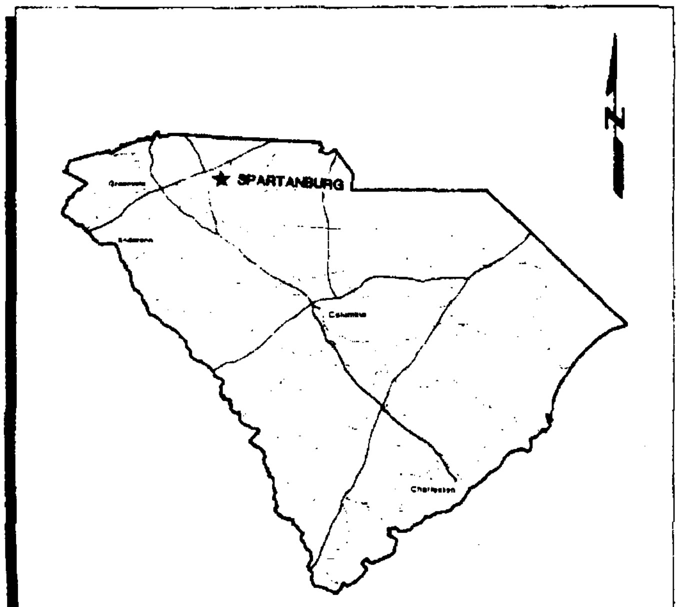
A.4 Source of Cleanup Monies

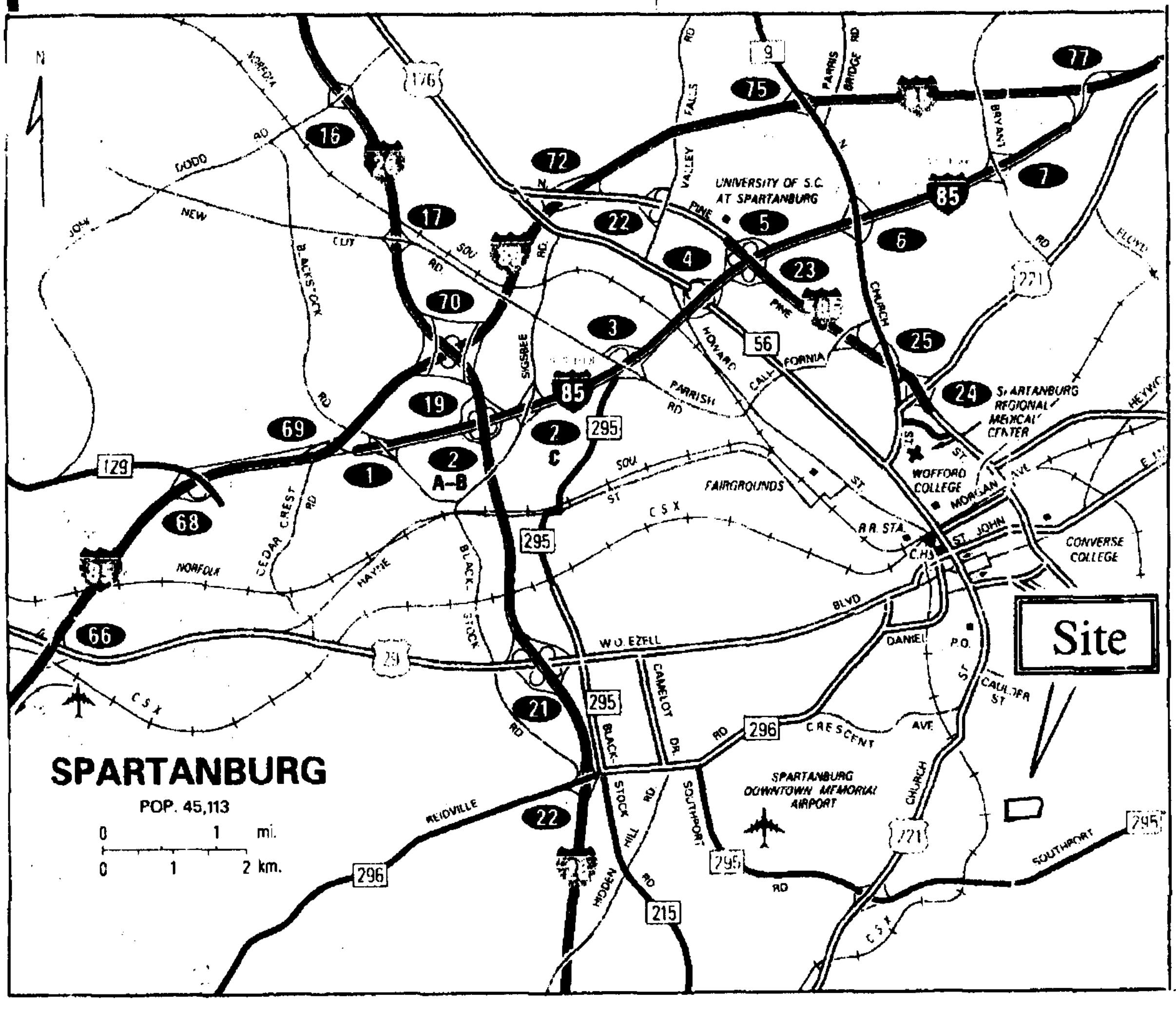
Pursuant to the Administrative Order on Consent for the RI/FS, effective November 30, 1999, costs for the RI/FS and for EPA oversight have been paid by The City of Spartanburg. EPA intends to negotiate an order or consent decree with the city and other PRPs for RD/RA and for past response costs.

A.5 Brief Site Description

The Arkwright Dump Site is located at the north end of Hilltop Lane in the Arkwright community, immediately south of Spartanburg, South Carolina (see Figure A-2). During the 1950s and 1960s, the City of Spartanburg operated a landfill on the Site. The landfill is believed to have accepted primarily municipal wastes; however, available information indicates that medical, automotive, and other wastes were also disposed of in the landfill. In 1972, the dump was closed and a soil cover placed over the buried wastes. No development has occurred on the Site since the 1972 closure. In 1976 the City sold the property to a private citizen. To date, no operating records or permits for the landfill have been found by the city, SCDHEC, or EPA.

FIGURE A-1
Site Location





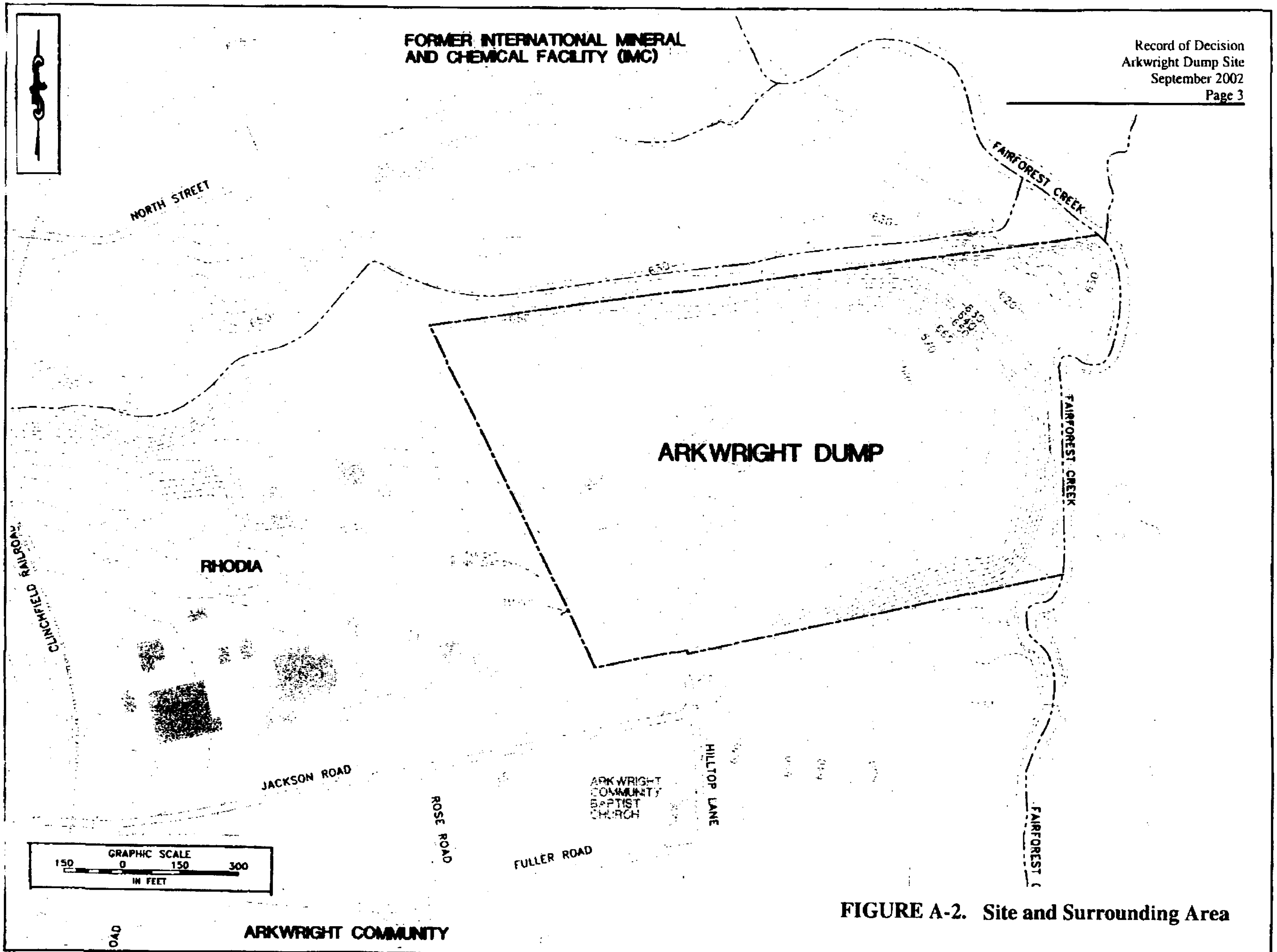


FIGURE A-2. Site and Surrounding Area

B. SITE HISTORY AND ENFORCEMENT ACTIVITIES

B.1 History of Site Investigations

State environmental agency records do not indicate any previous environmental investigations at the Site. State personnel at the local Appalachia District III office (Spartanburg) were aware of the existence of the former landfill and referred to it as "the Arkwright Dump." Spartanburg County and City of Spartanburg officials indicated they were unaware of any previous environmental work.

Information from a 1999 EPA study of aerial photography, nearby residents, and City of Spartanburg personnel indicates that a dump (later a landfill) was operated at the Site by the City during the 1950s and 1960s. The landfill is believed to have accepted primarily municipal wastes; however, available information suggests that medical, automotive, and other wastes were also probably disposed of in the landfill. In 1972, the dump was closed and a soil cover placed over the buried wastes. The City of Spartanburg sold the property to a private citizen in 1976. No landfill operating records or permits have been located to date.

The Site was initially identified to EPA in February 1998 by the leader of a local community group. In early 1998, an EPA On-Scene Coordinator (OSC) of the Region 4 Emergency Response and Removals Branch conducted a site visit and walk-through and determined that no immediate, short-term threats to human health were present. Based on discussions with the nearby community and after consultation with SCDHEC representatives, EPA then elected to evaluate the Site under Superfund using Federal contract resources. A Preliminary Assessment (PA) was completed between June and September 1998, recommending that additional sampling be conducted. A Site Inspection (SI) was then conducted between October 1998 and May 1999, which identified the presence of a number of hazardous substances including inorganic compounds (heavy metals), pesticides, and organic chemicals. These substances were present in Site soils, groundwater, surface water, and sediment.

During 1998 and 1999, EPA conducted initial and confirmatory sampling events on five (5) potable water wells, representing all those known to be in use within 1/4-mile of the Site. Based on these sample results, Region 4's Emergency Response and Removals Branch connected two nearby residences having affected private water wells to the Spartanburg municipal water supply, in May 1999. Remedial Investigation findings indicate that the contamination in those wells is highly unlikely to originate from the Site.

B.2 CERCLA Enforcement Activities

During June and July 1999, EPA Region 4 staff and representatives of the City of Spartanburg met and discussed the need for further investigation and eventual cleanup of the Site. These discussions culminated with the signature of an Administrative Order on Consent (AOC) for a

Remedial Investigation/Feasibility Study (RI/FS). The agreement was signed by EPA and became effective on November 30, 1999. In view of the agreement, EPA decided not to list the Site on the NPL, but rather to address the Site under an NPL-equivalent process (now known as the "Superfund Alternative Cleanup approach").

PRP search and other enforcement activities have been ongoing throughout the RI/FS. Enforcement work to date indicates other potentially responsible parties (PRPs) involved with the site. EPA intends to negotiate an order or consent decree with the city and other PRPs for RD/RA and for past response costs.

C. HIGHLIGHTS OF COMMUNITY PARTICIPATION

In February 1998, the leader of a local community advocacy and redevelopment group identified the Arkwright Dump Site to EPA staff at an Environmental Justice conference in Atlanta. Most nearby residents belong to the community group, "Re-Genesis," which had (prior to non-profit incorporation) more than 1400 members. Earlier, in August 1997, an EPA Community Relations Coordinater was first contacted by Re-Genesis' leader regarding his concerns about the former IMC Fertilizer plant, which adjoins Arkwright Dump along the northern boundary (Figure A-2). Throughout all Superfund work since 1998, there has been strong and consistent activity and interest by Re-Genesis. The group initially formed around health concerns about a number of nearby sites and facilities. The Arkwright Dump and former IMC Fertilizer sites represent only a portion of the community's larger, area-wide concerns.

Community involvement for the RI/FS at this site cannot be separated from the context of the remarkable, larger and wide-ranging community-driven project undertaken by Re-Genesis since 1998, which is actively seeking to bring about community revitalization, redevelopment, and/or reuse of nearby properties and areas. This effort is likely to significantly change the character of the Site-surrounding area and bears on the land-use considerations in this Record of Decision.

In March 1998 EPA began preparations for conducting Preliminary Assessment/Site Inspections on both the former IMC Fertilizer and Arkwright Dump sites. EPA and SCDHEC conducted a Public Meeting, hosted by Re-Genesis, in April 1998 to present the planned Site Assessment work to the community. Although pleased with the plans for investigation of the Site and the adjoining former IMC Fertilizer plant, community members expressed frustration with what was described as many years of government inaction in responding to their health concerns about the Site and other nearby sites. They also expressed interest in a number of outreach areas such as redevelopment grants, "Brownfields" projects, Environmental Justice initiatives, and training on the Superfund process.

Before the SI began, in May 1998, EPA staff presented a briefing to Re-Genesis' Board of Directors concerning the site assessment work at both the Site and the adjoining former IMC Fertilizer site. Following up from the April public meeting, EPA then presented two sessions of training to a total of approximately 80 local community attendees in late June 1998. Also in June 1998, EPA met with representatives of the City of Spartanburg and Spartanburg County, to explain the planned site assessment work as had been done with Re-Genesis. Ongoing dialogue continued through the summer of 1998, and included a series of community interview sessions by EPA and by its SI Contractor, which provided useful information about operations on the Site and nearby properties. Upon completion of the PA (September 1998), EPA used this information in planning the SI sampling onsite, which occurred in late October 1998.

Upon SI completion in May 1999, EPA issued a Fact Sheet concerning the Site sampling results and EPA's intention to seek further work at the Site. Discussions with City of Spartanburg representatives during the summer of 1999 led to the City's agreement to conduct an RI/FS. As part of the agreement, the City volunteered to arrange and fund ($25,000) a Technical Advisor to work with for Re-Genesis, in order to more effectively involve group members in understanding and commenting on RI/FS documents. EPA signed the Administrative Order by Consent (AOC) for the RI/FS on November 30, 1999.

In early 2000, EPA established two local information repositories, to facilitate public review of information concerning both the Site and the former IMC Fertilizer Site. Staff at CC Woodson Recreation Center, closer to the site, agreed to maintain Site materials and make them available to the public on request. The Spartanburg Public Library main location, on Church Street in the downtown area, hosts a second set of Site materials. Administrative Record binders are available at both locations.

In planning for the RI/FS during January through June 2000, the City's RI/FS Contractor arranged for long-time residents' input and review of possible waste areas and locations, as had EPA's contractor during 1998. A fact sheet describing the planned RI activities, entitled "RI/FS Update," was issued in May 2000. Re-Genesis volunteered to distribute the fact sheets within their organization, which assisted EPA in its efforts to inform the community.

On July 24, 2000, an "RI Kickoff" meeting was held at Community Baptist Church, located just south of the Site. This meeting focused on then-upcoming fieldwork and the anticipated time periods expected for completing the RI and FS Reports, and also included a discussion of the "Presumptive Remedy" concept. EPA and Contractor staff who were preparing the Draft Community Involvement Plan attended the meeting and conducted the first of the community interviews that same week.

The planned sampling was completed in September 2000. However, the need for an additional phase of sampling (later designated "Phase II") soon became evident. Planning of this work took place in early 2001, followed by field work between April and September 2001. Work since October 2001 has focused on revising and finalizing the RI, FS, and risk documents.

Extensive informal communication with Re-Genesis continued throughout the two phases of the

RI. During this time the community pursued its area-wide redevelopment efforts. In 1999 the area was designated as a "Demonstration Project" of the Federal Environmental Justice Interagency Working Group. "The Re-Genesis Project," as it is now known, has secured other funding resources and added a number of agencies, stakeholders and other parties to the partnership. In May 2000 ReGenesis hosted an official delegation from South Africa who were interested in Re-Genesis' progress as an example of citizen-led community revitalization and improvement. In partnership with Spartanburg County, The ReGenesis Project eventually secured an EPA Redevelopment Grant (July 2000), a State Revolving-Fund Brownfield grant (2000), a Federal Brownfields grant (April 2001), a line-item Federal appropriation through the US Department of Housing and Urban Development for neighborhood redevelopment, and (to the State) a Federal DOT appropriation for $1.2M for road design and construction (July 2002). The group has hosted four local redevelopment forums, two during 2000 and another two in 2001.

In addition to informal communications between EPA staff and Re-Genesis, EPA issued a series of "RI/FS Update Fact Sheets" to keep the community apprised of developments. "RI/FS Update Fact Sheet No. 2" was issued in March 2001, No. 3 in October 2001, and No. 4 in June 2002. Re-Genesis continued to assist Region 4 by distributing the sheets within their membership; generally, 150 or 200 copies were provided each time. EPA has also used and maintained a mailing list to provide information to all interested parties beyond the area close to the Site.

Throughout the RI/FS EPA solicited input on the anticipated land usage in the future. While planning work has not proceeded as fast as desired by Re-Genesis, sufficient general plans are in discussion that will allow EPA to account for them in this document (see Section F).

On July 23, 2002, EPA issued a Press Release through the Regional Office of Public Affairs, announcing issuance of the Proposed Plan and the planned public meeting date. Proposed Plan Fact Sheets were mailed out to Re-Genesis and to the mail list on July 19, 2002. A newspaper advertisement announcing the Proposed Plan, the Comment Period opening, and the meeting date, appeared in the Sunday edition of the Spartanburg Herald-Journal on July 21, 2002. The Proposed Plan Public Meeting was held on August 6, 2002. Community members raised a number of questions about the RI findings, the cap proposed in the remedy, health concerns, and other issues. Two sets of written comments, and one question on an EPA form provided at the meeting, were also received. EPA's responses to these questions and concerns is presented in Responsiveness Summary portion (Appendix A) of this Record of Decision.

D. SCOPE AND ROLE OF THE RESPONSE ACTION

The selected remedy described in Section L of this document is intended to be the final action for cleanup at this site. The remedy will address all risks posed by the affected media:

- Contaminated surface and subsurface soils, and
- Site groundwater and contaminated groundwater migrating offsite and entering surface water (Fairforest Creek).

Capping is EPA's Presumptive Remedy for municipal landfill sites. Therefore, capping is a component of the Site remedy. Contact with contaminated soils, and erosion of soils allowing offsite migration of the contaminants, will be addressed though the construction of a suitable engineered containment cover (cap) in accordance with the Presumptive Remedy. Onsite and offsite groundwater contamination will be addressed through insitu groundwater treatment, as described in Section L.

Completion of this remedy is expected to leave the property suitable for redevelopment, as long as property usage is consistent with the anticipated future use of the Site, which envisions one or more types of recreational use (Section F).

The EPA Region 4 Emergency Response and Removals Branch connected two nearby residences with contaminated water supply wells to the Spartanburg municipal water system in May 1999. (As noted earlier, subsequent RI work indicates the Site is highly unlikely to be the origin of contamination in those wells.) Other than CERCLA Site Assessment, the RI/FS is the only other response action to date. Future response actions as described in this Record of Decision will be implemented under CERCLA authority unless delegated to the State in accordance with applicable EPA policies.

E. SITE CHARACTERISTICS

E.1 Site Physical Setting

E.1.1 Topography and Surface Features

The Site is a rectangle-shaped 30-acre property bounded by Fairforest Creek to the east, a former fertilizer plant property (IMC) to the north, an active chemical-manufacturing facility (Rhodia) to the west, and homes to the south and southeast. As shown in Figure A-2, the Site lies on a northeast- to southwest-trending ridge, and slopes eastward toward Fairforest Creek, which forms the eastern Site boundary. Surface elevations range from 688 feet above mean sea level (MSL) at the top of the ridge to approximately 615 feet MSL along Fairforest Creek. The landfill has a soil cover of variable thickness and has a heavy growth of kudzu, trees, and natural vegetation. Only one structure probably related to the landfill remains at the Site, a small brick gate-house or office, located in the center of the Site along the old main road which was along the ridge line.

In addition to overland drainage toward Fairforest Creek, some portions of the northern half of Site drain to an unnamed tributary along the northern boundary with the IMC property, which flows east and converges with Fairforest Creek. Fairforest Creek flows to the south. The estimated annual mean flow rate for Fairforest Creek, measured approximately 1.25 miles downstream of the Site, was 37.8 cubic feet per second (cfs) for 1996 and 32.7 cfs for 1997. West of the main ridge, in the northwestern corner of the Site, standing water in a low-lying area has been observed for short periods, which appears to be a recurring but non-permanent feature. Portions of the Site along Fairforest Creek lie within the 100-year flood plain, and flat-lying areas along the creek's banks are classified as wetlands.

Research conducted during the RI found no known areas of historical or archeological importance on or immediately near the Site.

E.1.2 Regional and Site-Specific Geology/Hydrogeology

The Site lies within the Inner Piedmont Belt of the Piedmont Geologic Province. The Inner Piedmont belt is one of several elongated, northeast-southwest trending geographic zones which make up the Southern Piedmont Province. Bedrock of this province is the product of regional metamorphism that formed several metamorphic rock types including biotite gneiss, biotite schists, quartzite, hornblende gneiss, and other gabbro-type rocks, of Precambrian to early Paleozoic age. Volcanic intrusions are also common throughout the Inner Piedmont Belt. In less-weathered zones within bedrock, fractures develop along bedding and cleavage planes and are capable of transmitting appreciable amounts of water.

Across the Inner Piedmont, the crystalline rocks have weathered into a soft clayey or sandy saprolite. Saprolite is produced when rock has been weathered in-situ (in place), through chemical alteration by infiltrating rainwater. Saprolite exhibits some structural and mineralogical characteristics of the underlying parent rock such as foliation, bedding and fractures. It can be present from the surface to as deep as 100 feet or more.

Competent bedrock was encountered onsite in several soil and monitoring well borings, at depths ranging from 25-30 feet to 50-55 feet below land surface (BLS). Rock core samples collected from several of the monitoring well borings were predominantly granite gneiss with biotite schist. Biotite gneiss bedrock observed onsite (Fairforest Creek) consisted of medium to coarse-grained quartz and feldspar with accessory biotite and muscovite. These rock types weather to a dark red, clay-rich saprolite. Soils in the Site area represent the Madison-Congaree-Cecil-Worsham soil series, which are deep, well drained, gently sloping soils displaying moderate infiltration, permeability, and water-capacity characteristics.

Regionally, the primary source of recharge to aquifers is surface infiltration, typically in the form of precipitation and snowmelt. Because rainfall is plentiful throughout most of the year, the water table is mainly affected by surface features, and tends to follow the elevation contours of the land surface. The mountainous and rolling terrain favors heavier groundwater recharge in low-lying regions rather than at higher elevations. Water table depth can range from a few feet below the surface in low-lying areas, to more than 100 feet at higher elevations

Groundwater in the Piedmont Province occurs in a complex and interconnected two-part system of alluvium/saprolite, and underlying bedrock. Individual aquifers within the area are not extensive, and most potable water is supplied by streams and lakes. Well yields vary greatly and depend upon the rock type, saprolite thickness, and whether fractures or zones of groundwater flow are intersected. Higher-yielding wells typically extend to depths of 150 to 250 feet, and intersect water-bearing fractures and faults.

RI activities included the completion of numerous borings for installing both temporary and permanent groundwater monitoring wells. The Site's hydrogeologic setting consists of a vadose (unsaturated) zone of saprolite, or in some places alluvium (streambed sediment), underlain by a water table (unconfined) aquifer. The water table is relatively shallow and appears to mimic the surface topography. Depth to the water table onsite ranges from approximately 6 to 42 feet BLS. Water in the shallow water table aquifer moves downgradient (Figure E-1), generally west to east, until it discharges into Fairforest Creek. Site groundwater appears to recharge from infiltrating rainwater on the higher elevation areas to the west. Based on a series of hydraulic conductivity tests on Site monitoring wells, and assuming an effective porosity of 0.45, the estimated horizontal groundwater flow velocity in the shallow aquifer is about 450 feet per year.

Measurements from wells in the deeper bedrock aquifer show a depth to groundwater ranging from approximately 8 to 63 feet BLS. As with the shallow aquifer, the groundwater flow direction is also generally eastward across the site, toward Fairforest Creek (Figure E-2). A slight upward vertical hydraulic gradient was recorded in monitor well clusters MW-1A/B and MW-4A/B/C/D, which are located along Fairforest Creek. The upward gradient indicates that the bedrock aquifer is draining upward into the bed of Fairforest Creek.

The aquifer system as a whole, onsite and regionally, is classified by EPA as "Class II B" and by South Carolina as "Class GB" groundwater. Both classifications indicate that groundwater from the aquifer system is a potential source of drinking water.

E.1.3 <u>Remedial Investigation</u>

After a planning period, the RI/FS was conducted in two field activity phases: July through December 2000 (Phase I), and April through September 2001 (Phase II). The RI comprised a large investigation that included collection and analysis of more than 280 samples of groundwater, surface water, soil vapor, soil and sediment.

RI soil sampling was tailored to the Presumptive Remedy, to the degree possible. Extensive screening-level VOC surface/subsurface soil samples (37/27 respectively) were collected with the objective of locating any "hot spots" of organic compounds capable of affecting groundwater. Representative sample sets (6 each) of surface water and sediment were collected. Also, since there was essentially no information on-hand about the landfill contents, sixteen test pits were excavated for this purpose, as well as to characterize and document any landfill contents having enforcement significance.

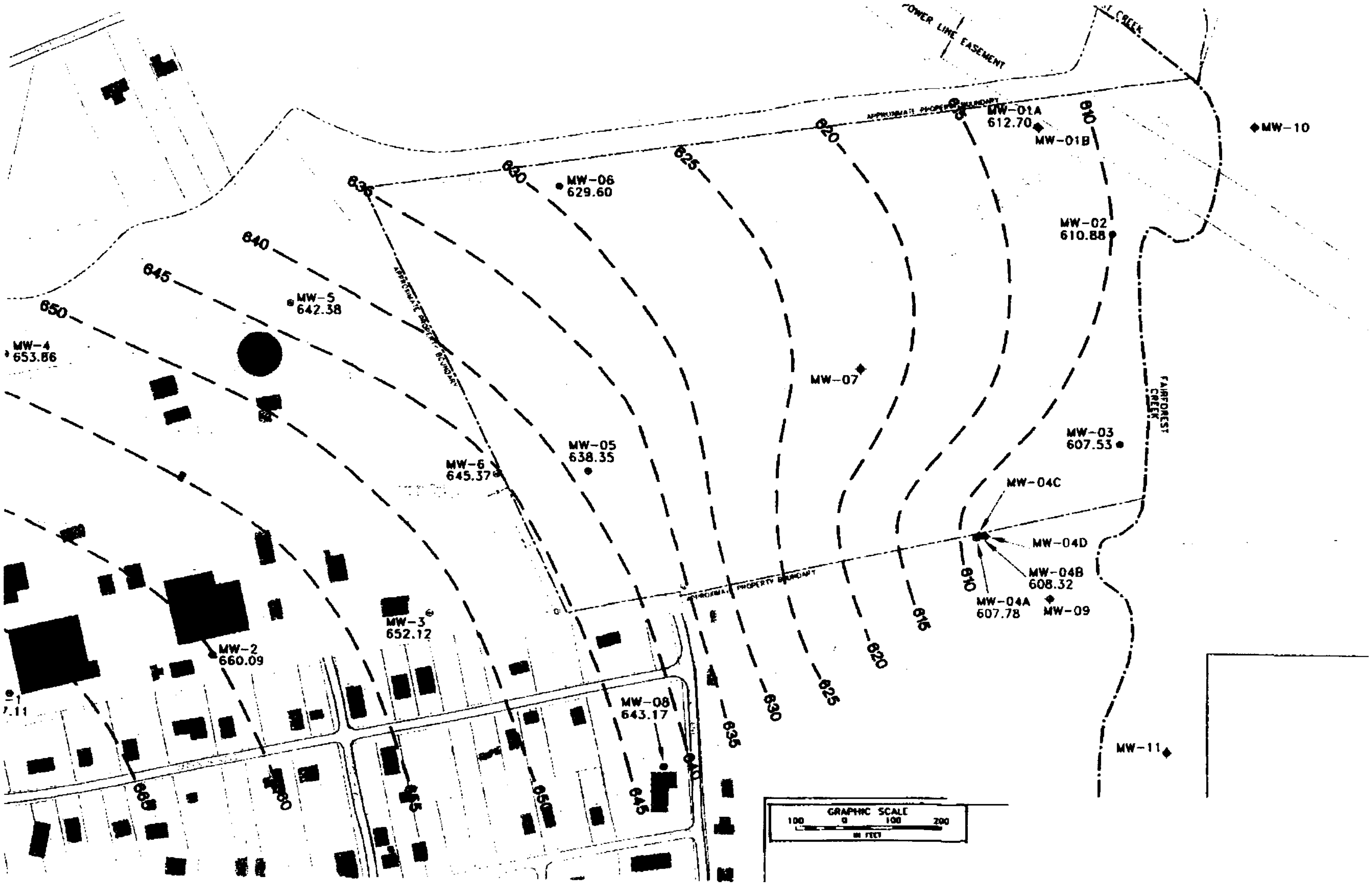


FIGURE E-1. Water Table (Shallow Aquifer) Potentiometric Surface Map

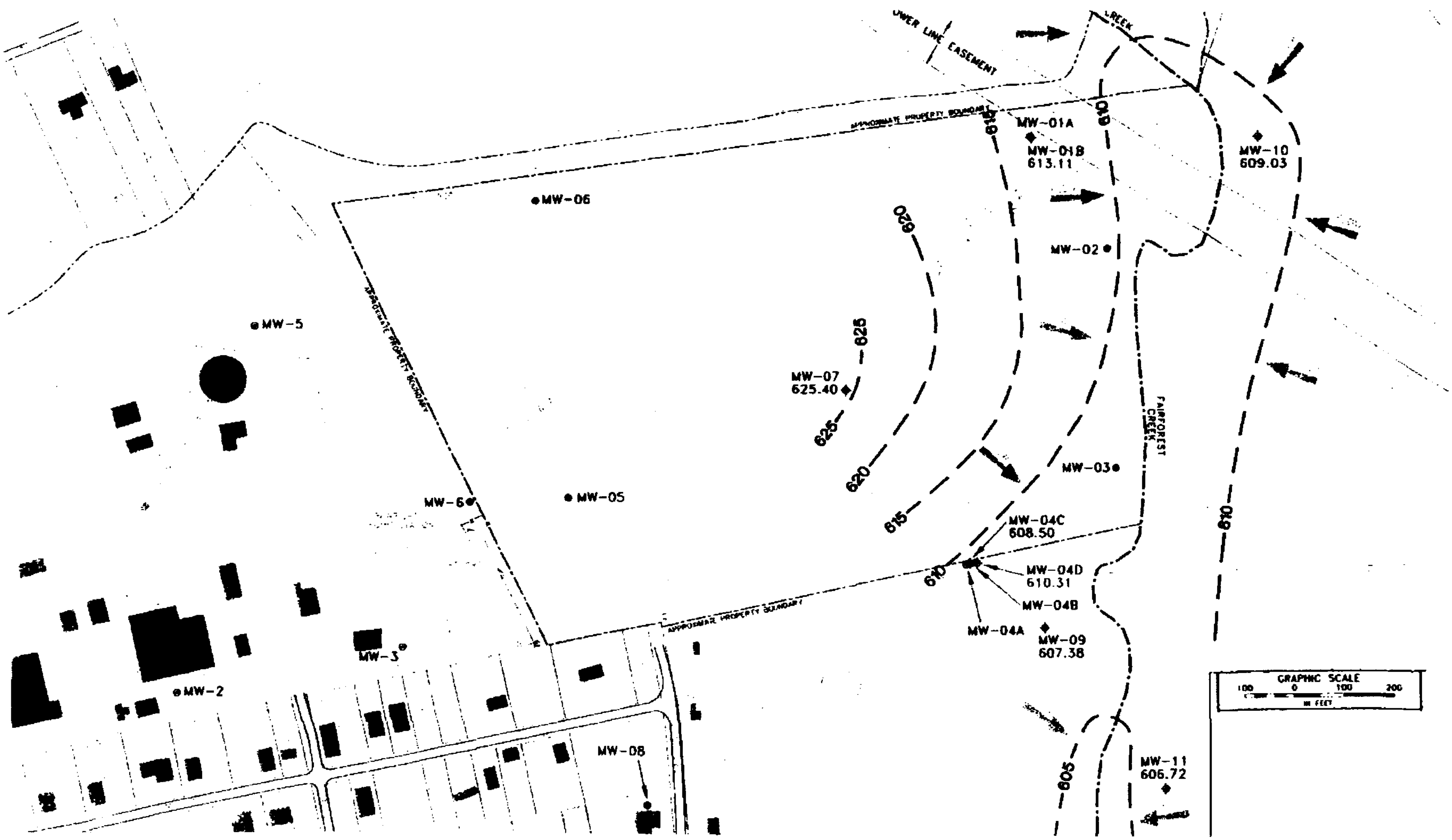


FIGURE E-2. Bedrock Aquifer Potentiometric Surface Map

Groundwater was investigated through the installation and sampling of 18 temporary monitoring wells, which then guided the placement of 15 permanent monitoring wells. Landfill gas emission was evaluated through installing and sampling 16 soil vapor wells and by conducting a soil-gas screening investigation. Figure E-3 shows the locations of all field samples collected during the RI.

Other than the landfill itself, no other potential contaminant sources of Site origin were found. Visual examination of landfill contents in test pits, considered together with the soil vapor and soil gas screening results, did not reveal any "hot spots" or areas of highly concentrated wastes. The materials seen were primarily municipal wastes (trash, plastic, glass, discarded household items, white goods), medical materials (gloves, plastic shrouds, hoods, bone fragments, syringes with needles, vials, bottles), and automotive wastes (gas tanks, wiring, miscellaneous auto parts, tires). Textile spools, bobbins and other discards were also present. An area of approximately 8-1/2 acres on the eastern toe of the landfill, an area of possible industrial wastes pointed out by residents, unfortunately proved inaccessible due to difficult field conditions which prevented safe excavation using heavy equipment.

Cross-sections of the test pits and groundwater monitoring wells indicated that the waste materials are generally above the water table depth across the landfill. According to a waste thickness map (Figure E-4) generated from Site borings, the waste pile ranges up to more than 44 feet thick. From Site boring data, the landfill waste volume is estimated to be approximately 745,000 cubic yards.

E.2 Nature and Extent of Contamination

E.2.1 Soil

As shown in Table E-1, eight organic and inorganic chemicals were found at levels more than two times above background or above a health screening value in surface soil, warranting consideration in the Baseline Risk Assessment (Potential Contaminants of Concern). This reflects the poor condition of the soil cover on the landfill. The most widely-detected chemical was dioxin, although levels were very low (below ½ microgram per kilogram (μg/kg) in all cases). Sixteen chemicals were detected above background levels in subsurface soils. Burning of waste materials at the surface and below ground is reported from the past, and may be the source of dioxins in soil. Throughout this document, the term "dioxins" will refer to the entire family of related congeners of 2,3,7,8-tetrachlorodibenzo-p-dioxin, as represented in RI samples by the summary "TEQ" figure.

E.2.2 Groundwater

Groundwater contamination (Table E-2) by volatile organic compounds (VOCs) is present, mainly in three monitor well clusters (MW-1, MW-2, MW-4) on the eastern half of the Site along

Fairforest Creek, and in an offsite well located southeast of the Site and along the creek (MW-9). The two main compounds are trichloroethylene (TCE) and tetrachloroethylene (PCE). TCE, PCE and four other VOCs exceed the Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act for aquifers which could be used as a potable water source.

Levels of PCE ranged up to 938 micrograms per liter (μg/l); TCE up to 230 μg/l; *cis*-1,2-dichloroethylene up to 290 μg/l; vinyl chloride up to 39 μg/l; and total VOCs up to approximately 1500 μg/l. From the RI, 47 detected chemicals were forwarded into the Baseline Risk Assessment for consideration.

The widespread detection of *cis*- and *trans*-1,2-dichloroethene and vinyl chloride, which are microbial degradation products of tetrachloroethene, indicates that biological degradation is occurring in the aquifer.

Phase II samples of shallow groundwater entering Fairforest Creek indicate that there are two general areas where VOC-contaminated groundwater is entering at low concentrations. Individual VOC levels range from 5 to 390 μg/L in the groundwater entering the creek. To the southeast, Site contaminants are present at MW-9 (see Figure E-3) and discharge to Fairforest Creek as far south as sample location MP-5, some 350 feet south of the property boundary. To the northeast, the VOC detections in groundwater feeding Fairforest Creek (samples MP-80 and MP-96, Figure E-3) probably also represent contaminated Site groundwater moving offsite, under the former IMC Fertilizer plant property. Location MP-96 is approximately 180 feet upstream, northwest, of the confluence of the unnamed tributary and Fairforest Creek.

These results, considered together with sample results from the Phase II deep well offsite to the southeast (MW-9); the absence of contaminants in the two Phase II deep wells on the east (offsite) side of Fairforest Creek (MW 10 and MW-11); and water table measurements from those same wells, indicate that contaminated groundwater is draining primarily to the creek and not moving offsite to the west or southwest (upgradient), where the nearest private drinking water wells are located. Although not shown in Table E-2, nine private water supply wells were sampled as a precautionary measure in the RI; two wells had lead (Pb) present above the MCL, and one well had a pesticide detection at the MCL. However, groundwater elevation measurements indicate clearly that the Site is downgradient of these wells and is not capable of impacting them. None of the wells are used for potable water supply.

In the FS, the total area underlain by groundwater contaminated above standards was estimated to be 7 acres. Considering the RI data and assuming an average affected aquifer thickness of 50 feet, with an effective porosity of 0.45, the estimated volume of contaminated groundwater is 7.2 million gallons. This estimate should be regarded as preliminary, in view of the limited number of wells (data points) defining the area.

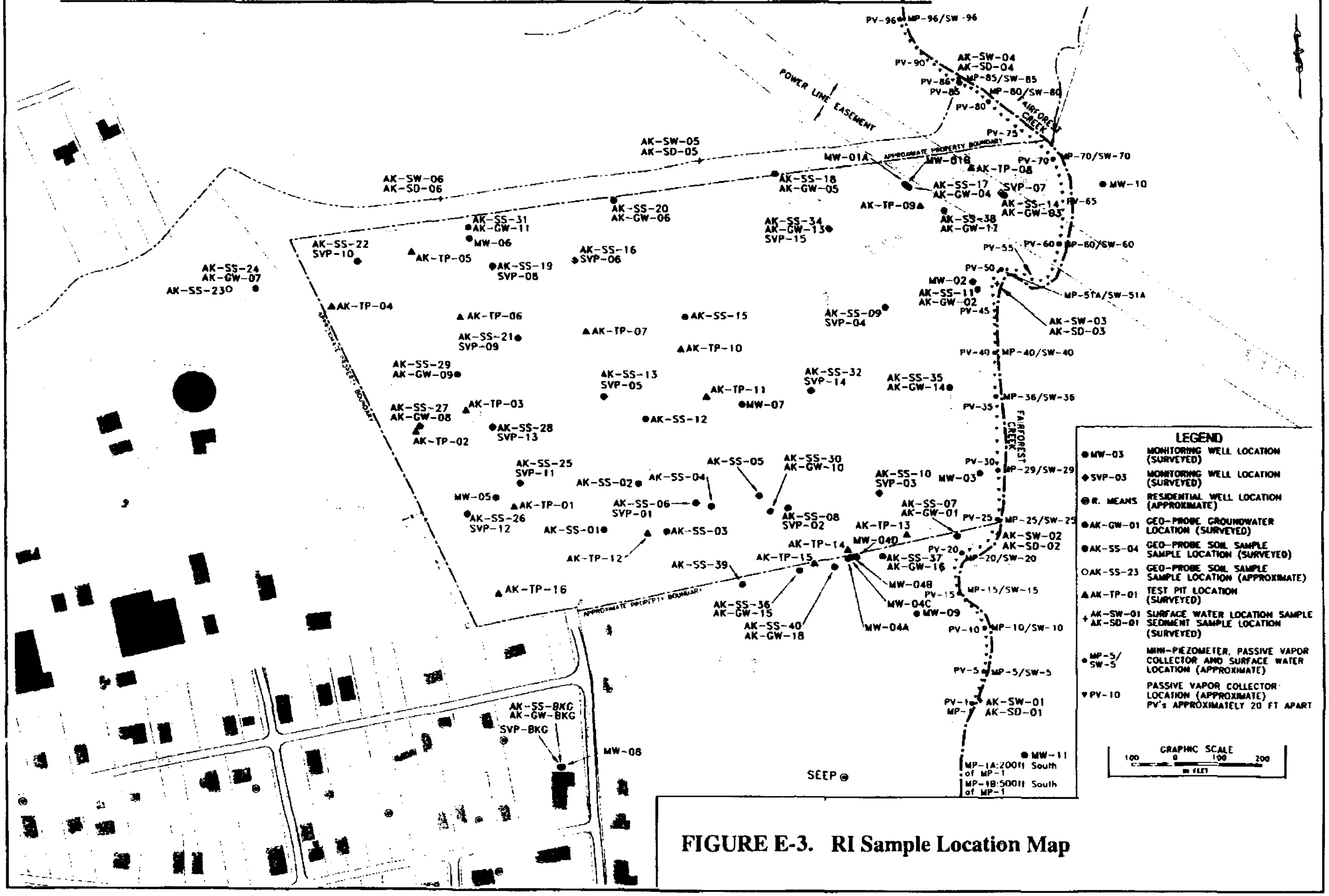


FIGURE E-3. RI Sample Location Map

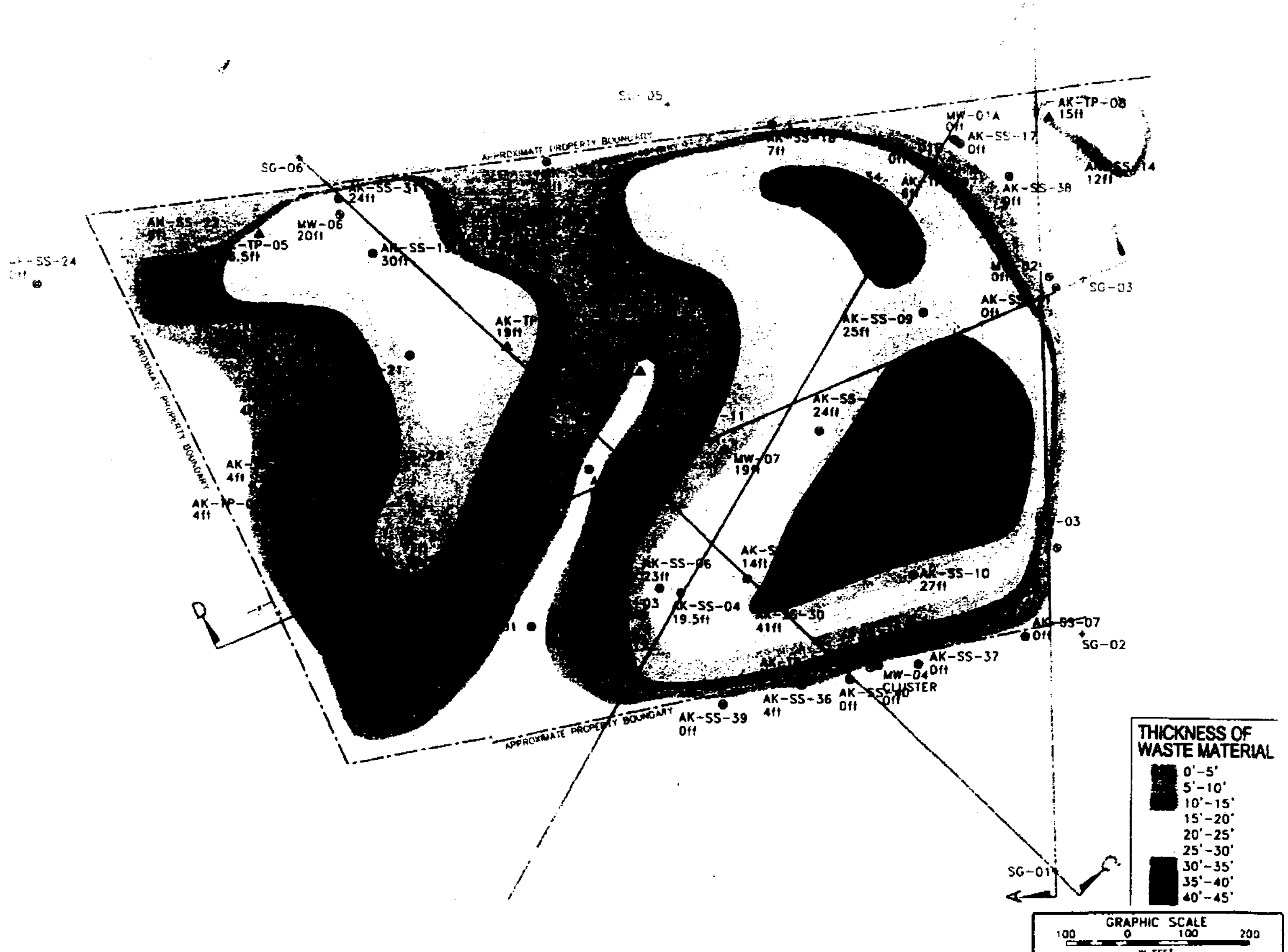


Figure E-4. Landfill Waste Thickness Map

TABLE E-1
Surface and Subsurface Soil Sample Results

Surface Soils					
Chemical	**No. Samples**	**No. Detections**	**No. above Standard**	**Maximum Detected**	**Comparison Standard Exceeded**
			Inorganics (mg/kg)		
Antimony	7	3	2	11	2X Background
Arsenic	7	7	2	12	PRG-Res, PRG-Ind[1]
Copper	7	7	1	550	2X Background
Cyanide	7	1	1	5.35	2X Background
Lead	7	7	5	520	PRG - *Residential*[1]
Zinc	7	7	6	1200	2X Background
			Semivolatile Organic Compounds (μg/kg)		
Benzo(a)pyrene	18	1	1	620	PRG-Res, PRG-Ind
			Dioxins and Furans (ng/kg)		
2,3,7,8-TCDD Equivalent	18	6	5	404	PRG - Residential

Subsurface Soils					
Chemical	**No. Samples**	**No. Detections**	**No. above Standard**	**Maximum Detected**	**Comparison Standard Exceeded**
			Inorganics (mg/kg)		
Antimony	10	2	1	8.5	2X Background
Arsenic	10	10	1	86	PRG - Res, PRG-Ind[1]
Cadmium	10	1	1	6.2	2X Background
Lead	10	10	5	1400	PRG - Res, PRG-Ind[1]
Zinc	10	10	1	2800	2X Background
			Semivolatile Organic Compounds (μg/kg)		
Benzo(a)pyrene	10	1	1	950	PRG-Res, PRG-Ind
Benzo(a)anthracene	10	1	1	820	PRG - Residential
Benzo(b)fluoranthene	10	1	1	880	PRG - Residential
			Pesticides (μg/kg)		
4, 4'-DDE	10	1	1	11	PRG - Residential
4, 4'-DDT	10	1	1	24	PRG-Res, PRG-Ind
			Dioxins and Furans (ng/kg)		
2,3,7,8-TCDD Equivalent	7	7	3	413	PRG-Res, PRG-Ind

Notes
"2X background" indicates detections are elevated more than two times above site-specific background level.
"PRG" refers to US EPA Region 9 Preliminary Remediation Goals (Nov. 11, 2000).
"Res" = Residential use scenario PRG.
"Ind" = Industrial use scenario PRG.
(1) Detected value was also elevated >2 times background.

TABLE E-2
Groundwater Sample Results

Chemical	No. Samples	No. Detections	No. above Standard	Maximum Detected	Comparison Standard Exceeded
Inorganics (mg/kg)					
Arsenic	17	1	1	0.005	PRG[1]
Manganese	17	17	8	5.3	PRG
Volatile Organic Compounds (μg/kg)					
Benzene	28	8	6	50	MCL (5), PRG
Chlorobenzene	28	11	1	17	PRG[2]
Chloroform	28	1	1	1.8	PRG
m-Dichlorobenzene	28	1	1	8	PRG
p-Dichlorobenzene	28	2	2	9	PRG
1,1-Dichloroethene	28	4	4	7.3	MCL (7), PRG[3]
cis-1,2-Dichloroethene	28	17	7	290	MCL (70), PRG[4]
trans-1,2-Dichloroethene	28	8	1	27	PRG[5]
Methylene Chloride	28	2	2	5	MCL (5), PRG[6]
Naphthalene	28	3	3	41	PRG
n-Propylbenzene	28	1	1	1	PRG[5]
Tetrachloroethene	28	11	11	938	MCL (5), PRG[4]
Trichloroethene	28	10	14	230	MCL (5), PRG[4]
1,2,4-Trimethylbenzene	28	2	2	13	PRG[7]
1,3,5-Trimethylbenzene	28	1	1	4	PRG[5]
Vinyl Chloride	28	12	12	39	MCL (2), PRG[4]
Semivolatile Organic Compounds (μg/kg)					
Bis (2-ethylhexyl)pthalate	28	1	1	14.6	PRG
Pesticides (μg/kg)					
alpha-BHC	10	2	2	0.17	PRG
beta-BHC	10	3	3	0.83	PRG
Dioxins and Furans (ng/kg)					
2,3,7,8-TCDD Equivalent	10	12	2	0.000740	PRG

Notes
(1) "PRG" refers to US EPA Region 9 Preliminary Remediation Goals (Nov. 11, 2000) for tap water.
(2) Detection is above 1/10 PRG and was forwarded into Baseline Risk Assessment for consideration.
(3) The max detection was >MCL, the 3 others > PRG.
(4) All detections marked "above standard" were >MCL and >PRG.
(5) The max detection was above the 1/10th PRG comparison used for noncarcinogenic contaminants.
(6) The max detection was >MCL and >PRG.
(7) Of the 2 detections marked "above standard" one was >PRG and 1 was >1/10 PRG.

E.2.3 Surface Water

Table E-3 highlights surface water detections. In general, the surface water results do not indicate a significant problem. Phase I RI sample results included elevated levels of three inorganic constituents and dioxin. Dioxin was present in two samples above background and above water quality criteria, but considering a background detection, it is not clear that the Site is the origin. Iron and aluminum were also detected at levels above Federal and State surface water quality standards; however, a clear Site origin could not be established.

The VOC detections shown in Table E-3 are from samples collected as part of the Phase II investigation of groundwater and Fairforest Creek. Individual VOC levels ranged between 1 and 10 μg/l. As shown, two of these surface water detections (TCE and PCE) equal or exceed the State and Federal surface water quality standard.

E.2.4 Sediment

Sediment sample results are included in Table E-3. Three inorganic substances and one organic chemical, dioxin, were detected but cannot be attributed with certainty to the Site. One organic chemical, p/p-xylene, was detected in one sample at 16 μg/kg.

E.2.5 Landfill Gas

Landfill gas samples (Table E-4) contained a large number of organic compounds at very low levels. The data for 20 organic compounds were forwarded for consideration in the Baseline Risk Assessment.

E.3 <u>Conceptual Site Model</u>

Figure E-5 presents the Conceptual Site Model, a diagram illustrating the key components of the present environmental situation. Components include the primary source(s), which is the origin of the hazardous substances present at a site; the release mechanism or means by which the contaminant gets into the environment; any secondary sources and their release mechanisms; the pathway, usually a medium such as soil or groundwater, along which contaminants move; an exposure route or means of entry into the body; and finally one or more receptors, the people or animals that are exposed to the chemicals of concern.

At the Arkwright Dump Site, the primary source of contaminants is the waste within the landfill, primarily located in the vadose (unsaturated) zone above the water table. Biodegradation and volatilization release the chemicals of concern (COCs) into soil gas (landfill gas), which eventually releases into the ambient air above the ground surface. Exposure could occur from inhaling these vapors. Leaching from the waste, primarily from the action of rainwater percolating through it, contaminates the underlying deep soil and eventually brings the COCs into groundwater.

TABLE E-3
Surface Water and Sediment Sample Results

Surface Water					
Chemical	**No. Samples**	**No. Detections**	**No. above Standard**	**Maximum Detected**	**Comparison Standard Exceeded**
Inorganics (mg/kg)					
Aluminum	7	7	1	0.95	2x Bkgd, R4 Ecol(1)
Iron	7	7	1	1.0	2x Bkgd, R4 Ecol
Manganese	7	7	6	0.16	2x Bkgd
Organic Compounds (μg/kg)					
cis-1,2-Dichloroethene	13	6	-	10	(Detected)
Tetrachloroethene	13	2	1	2.0	RWQC - HH (org)(2)
Trichloroethene	13	1	1	2.0	RWQC - HH (org)(2)
Vinyl Chloride	13	1	-	1.0	(Detected)
Dioxins and Furans (ng/kg)					
2,3,7,8-TCDD Equivalent	7	3	2	0.00014	RWQC - HH (org)(2)

Sediment					
Chemical	**No. Samples**	**No. Detections**	**No. above Standard**	**Maximum Detected**	**Comparison Standard Exceeded**
Inorganics (mg/kg)					
Arsenic	6	4	1	5.2(3)	2x Bkgd
Iron	6	6	1	19,000(3)	2x Bkgd
Organic Compounds (μg/kg)					
m/p-Xylene	6	2	-	16	(Detected)
Dioxins and Furans (ng/kg)					
2,3,7,8-TCDD Equivalent	6	6	(Note 4)	1.01	(Detected)

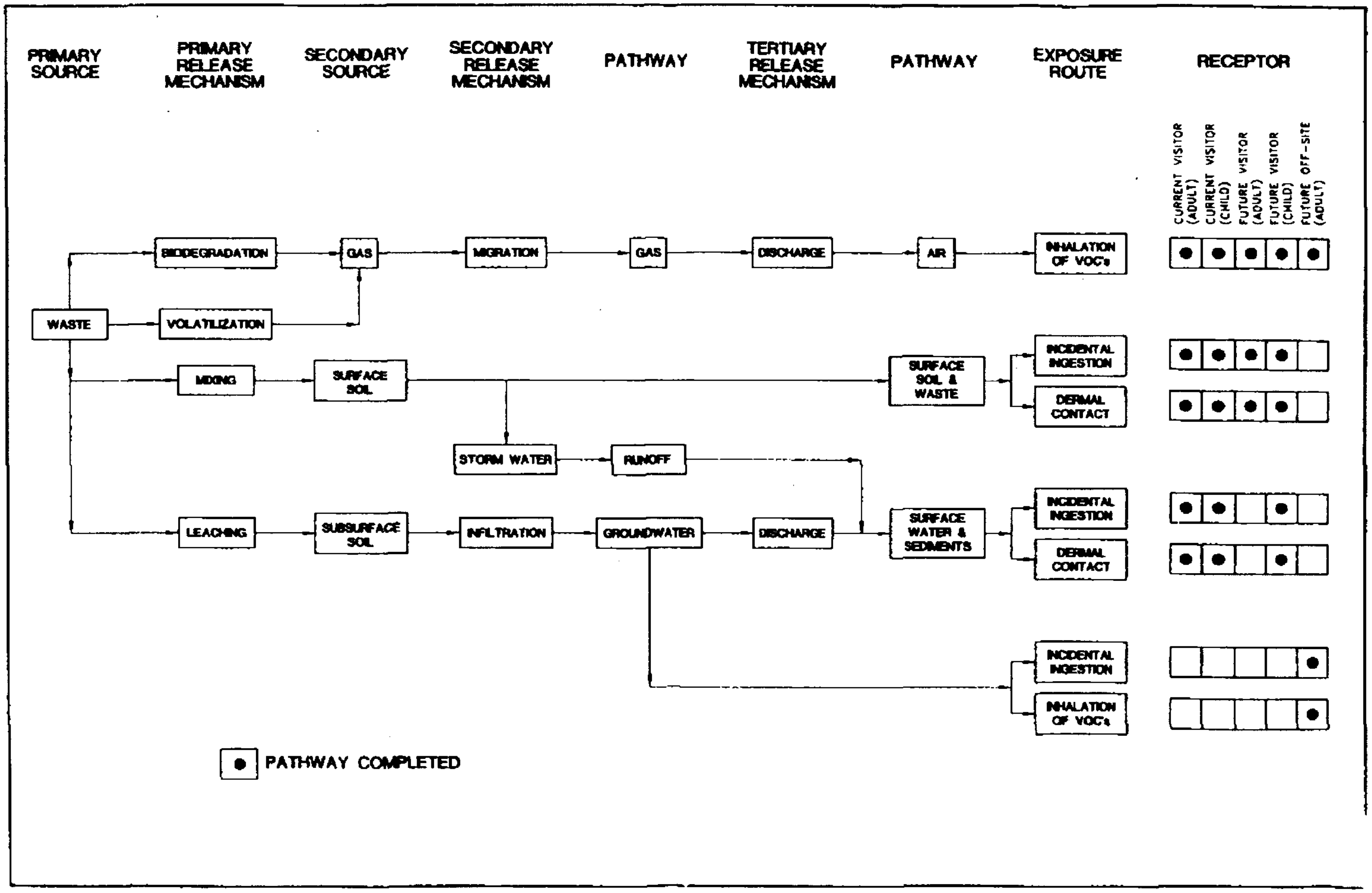
Notes
"Bkgd" = background.
(1) "R4 Ecol" refers to US EPA Region 4 Ecological Screening Values, for both Surface Water ("Freshwater") and Sediment. Posted at http://www.epa.gov/region4/waste/ots/ecolbul.htm#tbl3
(2) "RWQC - HH (org)" refers to the *National Recommended Quality Criteria - Correction*, US EPA Publication 822-Z-99-001, April 1999 (57 FR 60848), and SC Regulation 61-68, Water Classifications and Standards, amended 6/22/01: Protection of Human Health, number for consumption of water & organism..
(3) These maxima were detected at SD-04, slightly upstream of the property boundary, and are likely not attributable to the Site.
(4) The background detection, upstream of the Site, was at the EPA Region 4 screening value (2.5 ng/kg). The Site maximum detected was 1.01 ng/kg, as shown.

TABLE E-4
Landfill Gas Sample Results

Chemical	No. Samples	No. Detections	No. above PRG[1]	Maximum Detected
Volatile Organic Compounds (ppbv)				
Benzene	15	7	7	9,500
Chlorobenzene	15	7	7	2,500
Chloroform	15	-	-	ND[2]
Cryoflourane (Freon 114)	15	13	(Note 3)	430
p-Dichlorobenzene	15	6	6	520
Dichlorodiflouromethane	15	13	10	420
cis-1,2-Dichloroethene	15	5	2	150
Ethylbenzene	15	5	1	990
Ethyl chloride	15	1	1	15
Methyl chloride	15	2	2	200
Methylene chloride	15	2	2	14
Tetrachloroethene	15	10	10	130
Toluene	15	2	1	150
Trichloroethene	15	2	2	1,600
Trichloroflouromethane	15	10	2	38
1,2,4-Trimethylbenzene	15	10	9	1,900 [2]
1,3,5-Trimethylbenzene	15	5	3	660[2]
Vinyl Chloride	15	5	5	750
m/p-Xylene	15	4	1	2,300
o-Xylene	15	6	1	350

Notes
(1) "PRG" = US EPA Region 9 Preliminary Remediation Goal for ambient air.
(2) Detection was in background sample. Not detected at Site.
(3) No PRG established.

FIGURE E-5
Conceptual Site Model



Evidence to date indicates the COCs move with groundwater until they discharge to Fairforest Creek. Exposure to the creek water and sediments, through wading in the creek and direct contact with both water and sediment, are possible exposure routes. In a possible future use scenario, groundwater could be used as a potable water source, so that exposure could occur through ingesting the water or inhaling vapors from it.

F. CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

F.1 Land Use

Spartanburg County controls land usage but does not use zoning ordinances. Thus the Site property is not zoned for any particular type of usage. No development or other Site use has occurred since the landfill closed in 1972. The property was purchased from City in 1976 by a local citizen, who transferred ownership to his son in 1996. Observations during EPA Site Assessment work, and discussion with local residents, indicated that children play on the dump property, and that adults cross the property on foot. Evidence of target shooting was observed.

Current land use around the site is mixed. Residential areas are located south and west of the Site, as well as to the east across Fairforest Creek. Active industrial plants nearby include Rhodia Division of Rhone-Poulenc, Arkwright Mill, and a Zupan concrete production facility. Other uses within ½-mile include auto repair and salvage yards, churches, offices, and convenience stores.

The expected future land use for the Site and surrounding areas is undetermined at present. Dialogue with representatives of the County, City, and the community group Re-Genesis (see Section C) indicates a clear preference for recreational use of the Site property once the remedy is in place. The types of activities they envision include a "Greenway Space" along Fairforest Creek that would connect to other belts or trails, bicycle trails, and open grassed fields for informal sports or outdoor-fair-type events.

In addition to the current situation of homes and industrial facilities in close proximity, one of the community's concerns is a lack of nearby retail businesses such as grocery stores and pharmacies. There is also a community perception that local development and growth is occurring elsewhere in the area, but passing the "southside" by. The momentum, size and scope of the ongoing "Regenesis Project," and the number of project partners and stakeholders, seem likely to bring about a wider range of land uses (retail, shopping, light commercial) on nearby properties in the future.

F.2 Groundwater Use

Groundwater is not used at the Site, but nearby private water wells within 1/4-mile are in use for non-potable uses such as irrigating lawns and gardens, and washing cars. EPA connected the only two known nearby water well users to the Spartanburg Water System in 1999; no other wells for potable water supply are known to exist within 1/4-mile of the Site. Within one mile, 51 persons are estimated to use groundwater for their potable water source. The vast majority of nearby water use is supplied by the Spartanburg Water System, which obtains water from nearby Lake Bowen and from the South Pacolet River. However, the State of South Carolina and EPA groundwater classifications for the area indicate that groundwater from the aquifer system is considered a current and potential future source of drinking water.

G. SUMMARY OF SITE RISKS

G.1 Summary of Human Health Risk Assessment

The baseline risk assessment estimates what risks the Site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the Baseline Risk Assessment for this site.

Although EPA Presumptive Remedy Guidance allows for streamlining of the Baseline Risk Assessment, the presence of numerous pathways other than soil contact (such as sediment and water contact, and potential groundwater use) led to the generation of a full quantitative assessment.

G.1.1 Chemicals of Potential Concern

Table G-1 presents the chemicals of potential concern (COPCs) detected in each medium, and the exposure point concentration for each (which was used to estimate the exposure and risk from each COPC). The table includes the range of concentrations detected for each COPC, the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the Site), the exposure point concentration, and how each exposure point concentration was derived. In all cases, the maximum detection was used as the default EPC in view of limited site data. The PCOCs represent those chemicals remaining after RI detections were screened against (1) average background concentration and 2) health-risk-based screening values. For all COPCs, quantitive risk calculations were performed to generate numerical risk estimates.

TABLE G-1
Chemicals of Potential Concern and Exposure Point Concentrations

Current and Future Use - Site Visitor

Medium: Soil **Units:** mg/kg
Exposure Medium: Surface Soil

Exposure Point	Chemical of Concern	Detected Concentration		Detection Frequency[1]	Exposure Point Concentration	Statistical Measure
		Minimum	Maximum			
Landfill surface soil	Arsenic	2.4	12	6/6	12	Max
	Benzo(a)pyrene (Equivalent)	0.62	0.62	1/17	0.736 (Note 2)	Max
	2,3,7,8-TCDD TEQ	0.00000148	0.000404	7/117	0.000404	Max
	4, 4'-DDT	0.01	0.0276	2/17	0.0276	Max
	4, 4'-DDE	0.01	0.01	2/17	0.01	Max

Future Use - Offsite Resident

Medium: Water **Units:** µg/L
Exposure Medium: Groundwater

Exposure Point	Chemical of Concern	Minimum	Maximum	Detection Frequency	Exposure Point Concentration	Statistical Measure
Ground-water	Arsenic	5	5	1/17	5	Max
	Barium	64	520	13/17	520	Max
	Chromium	9.3	27	7/17	27	Max
	Iron	51	39,000	15/17	39,000	Max
	Manganese	5.6	5,300	17/17	5,300	Max
	Benzene	1	50	8/28	50	Max
	Chlorobenzene	2.6	17	11/28	17	Max
	Chloroform	1.8	1.8	1/28	1.8	Max
	1,1-Dichloroethene	4.4	7.3	4/28	7.3	Max
	Cis-1,2-Dichloroethene	7	290	17/28	290	Max
	Trans-1,2-Dichloroethene	1.3	27	8/28	27	Max
	Methylene Chloride	1.0	5	2/28	5	Max
	Naphthalene	2	41	3/28	41	Max
	n-Propylbenzene	8	8	1/28	8	Max
	Tetrachloroethene	1.1	938	11/28	938	Max
	Trichloroethene	3.5	230	10/28	230	Max
	1,2,4-Trimethylbenzene	3	13	2/28	13	Max
	1,3,5-Trimethylbenzene	4	4	1/28	4	Max
	Vinyl Chloride	2	39	10/28	39	Max
	o-xylene	1.5	3	12/28	3	Max
	m/p-xylene	2	5	4/28	5	Max
	alpha-BHC	0.16	0.17	2/10	0.17	Max
	beta-BHC	0.28	0.83	3/10	0.83	Max
	PCB (Arochlor 1242)	1.45	1.45	1/24	1.45	Max
	2,3,7,8-TCDD Equivalent	4×10^{-4}	7.4×10^{-4}	12/24	7.4 x 10-4 (Note 3)	Max

Notes:

This table shows the PCOCs for the significant (risk-causing) media and pathways at the Site. Additional pathways were evaluated in the Baseline Risk Assessment.

Max - Exposure point concentrations are based on the maximum detected concentrations.

ND - not detected.

(1) Detection frequency is based upon temporary wells and permanent wells; since Phase 2 samples repeat some wells, detection in either phase counts as one detection.

(2) Although 0.62 was the max detection of BAP, other closely-related PAH detections were added to give an "Equivalent" value (EPA Guidance)

(3) The detected concentration, in nanograms, is 0.00074.

G.1.2 Exposure Assessment

The exposure assessment identified potential exposure pathways and quantifies the magnitude, frequency and duration of reasonable maximum exposure. Based on the expected future Site use and on the Site Conceptual Model (Section E-3), the Baseline Risk Assessment developed the following current use and future use scenarios in evaluating Site risks:

Current Site use:

- Exposures to COPCs by an adult Site visitor, who is onsite periodically for recreational purposes. The two exposure pathways through which the adult would be exposed to contaminants are contact with surface soil, and breathing vapors from Site COPCs in landfill gas.

- Exposures to COPCs by an adolescent child (age 7-12) Site visitor. The child has similar exposure as the adult, but also contacts surface water and sediment while playing in Fairforest Creek.

- Exposures to COPCs by a small child (age 1-6) Site visitor. The child is assumed to be supervised and thus to have only similar exposure to the adult.

Future Site use:

- Exposures to COPCs by adult, adolescent child, and small child Site visitors. These are the same as the three listed above.

- Exposures to COPCs in the groundwater by an adult offsite resident, from groundwater use as the potable water source.

- Exposures to COPCs in the groundwater by an adolescent child (age 7-12) offsite resident, from groundwater use as the potable water source.

- Exposures to COPCs in the groundwater by a small child (age 1-6) offsite resident, from groundwater use as the potable water source.

Persons who could be exposed to Site COPCs are referred to as "receptors." The assumptions and specific exposure factors (magnitude, frequency and duration of exposure, averaged exposure doses) are presented in Appendix B.

G.1.3 Toxicity Assessment

The toxicity assessment addresses the potential for a COPC to cause adverse effects in exposed populations (in this case, Site visitors or offsite residents using groundwater) and estimates the dose-response relationship, which is the relationship between extent of exposure, and extent of toxic injury. To assist in estimating the potential health effects, EPA has developed toxicity values which reflect the magnitude of the adverse noncarcinogenic and carcinogenic effects from exposure to specific chemicals.

Health effects caused by exposure to chemicals can be divided into two general types:
1) carcinogenic effects, which elevate the risk of a gene mutation or of a person developing cancer, and 2) noncarcinogenic effects, which involve damage to, or impairment of, various organ systems of the human body. In the two subsections which follow, brief descriptions of the development of the toxicity values for each type of effect (carcinogenic and non-carcinogenic) are provided.

G.1.3.1 *Noncarcinogenic effects*

Table G-2 provides the noncarcinogenic toxicity data used in the Baseline Risk Assessment. General information about the development and selection of these values is presented below.

Chemicals that cause non-carcinogenic effects are often referred to as "systemic toxicants" because of their effects on the function of various organ systems. For many noncarcinogenic effects, protective mechanisms (i.e., exposure or dose thresholds) are believed to exist that must be overcome before adverse effects occcur. This fact distinguishes systemic toxicants from carcinogens and mutagens, which are often treated as acting without a distinct threshold. As a result, for noncarcinogens there is some finite amount of exposure that can be tolerated with almost no chance of adverse effects occurring. The standard approach for developing toxicity values is to identify the upper bound of this tolerance range, which can be called a threshold, and to establish the toxicity values based on the threshold.

The toxicity value most often used in evaluating noncarcinogenic effects is a Reference Dose (RfD) for oral exposure (ingestion) or dermal exposure (skin contact), or Reference Concentration (RfC) for inhalation exposure. Various types of RfDs/RfCs are available, depending on (1) the exposure route of concern (e.g., oral or inhalation), (2) the critical effect of the chemical (e.g., developmental or other), and (3) the length of exposure being evaluated (e.g., chronic or subchronic).

Reference Doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals that exhibit noncarcinogenic effects. A chronic RfD or RfC is defined as an estimate of a daily exposure level that is likely to generate no appreciable risk of negative effects during a lifetime. RfDs, which are expressed in units of mg/kg-day, are

TABLE G-2
Noncarcinogenic Toxicity Data Summary

MEDIUM: SOIL (Current and Future Use - Site Visitor)
Pathways: Soil contact (incidental ingestion, absorption)

Chemical of Potential Concern	Oral RfD_o Reference Dose mg/kg-day	Source	Absorption RfD_d Reference Dose mg/kg-day	Source
Manganese	2.40E-02	IRIS	9.60E-04	IRIS Abs - 0.040 [ASTDR]
Antimony	4.00E-04	IRIS	4.00E-04	IRIS
Arsenic	3.00E-04	IRIS	3.00E-04	IRIS
Barium	7.00E-02	IRIS	7.00E-02	IRIS
Cadmium	5.00E-04	IRIS	1.25E-05	IRIS Abs - 0.025 [RAGS (Pt E)]
Copper	3.70E-02	IRIS	3.70E-02	IRIS
Cyanide	2.00E-02	IRIS	2.00E-02	IRIS
Selenium	7.00E-05	IRIS	3.85E-05	IRIS Abs - 0.55 [RAGS (Pt E) Mid-point of range (30-80%).]
Zinc	3.00E-01	IRIS	3.00E-01	IRIS
Dieldrin	5.00E-05	IRIS	5.00E-05	IRIS
4,4'-DDT	5.00E-04	IRIS	5.00E-04	IRIS

TABLE G-2
Noncarcinogenic Toxicity Data Summary (continued)

MEDIUM: GROUNDWATER (Future Use - Offsite Resident)
Pathway: Groundwater use (well water ingestion, inhalation and absorption while showering)

Chemical of Potential Concern	US EPA Classification	Oral SF_o Slope Factor (kg day)/mg	Source	Inhalation SF_i Slope Factor (kg day)/mg	Source	Dermal SF_d Slope Factor (kg day)/mg	Source
Arsenic	A	1.5	IRIS	NA	-	1.5	Extrapolated
Benzene	A	0.055	IRIS	0.027	Extrapolated	0.055	Extrapolated
Chloroform	B2	0.0061	IRIS	0.081	IRIS	0.0061	Extrapolated
p-Dichlorobenzene	C	0.024	HEAST	0.024	Extrapolated	0.024	Extrapolated
1,1-Dichoroethene	C	0.6	IRIS	0.18	IRIS	0.6	Extrapolated
Methylene chloride	B2	0.0075	IRIS	0.0016	IRIS	0.0075	Extrapolated
Tetrachloroethene	B2	0.052	EPA Prov.	0.002	NCEA.	0.052	Extrapolated
Trichloroethene	B2	0.011	EPA Prov.	0.006	NCEA	0.011	Extrapolated
Vinyl chloride	A	1.5	IRIS	0.03	IRIS	1.5	Extrapolated
Bis(2-ethylhexyl) phthalate	B2	0.014	IRIS	0.014	Extrapolated	0.014	Extrapolated
Aroclor (PCB) 1242	B2	1.0 [a]	IRIS	1.0	Extrapolated	1.0	Extrapolated
alpha-BHC	B2	6.3	IRIS	6.3	Extrapolated	6.3	Extrapolated
beta-BHC	B2	1.8	IRIS	1.8	Extrapolated	1.8	Extrapolated
2,3,7,8-TCDD Equivalents	B2	150,000	HEAST	NA	-	150,000	Extrapolated

NA – Not applicable due to volatility.
[a] Central estimate slope factor for high risk and persistence. Applicable to soil and water ingestion.

estimates of lifetime daily exposure limits for humans, including sensitive individuals (for example, children). Estimated intakes of contaminants of concern from environmental media (for example, the amount of a contaminant of concern ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (often to account for the use of animal data to predict effects on humans). Chronic RfDs/RfCs are specifically developed to be protective for long-term exposures, i.e., seven (7) years to a lifetime (70 years). In the Site Baseline Risk Assessment, exposures other than childhood exposures are assumed to be long-term. Child visitors age 7-12 years, and small child visitors age 1-6 years, are 6-year exposure durations in accordance with the Risk Assessment Guidance for Superfund (RAGS). The sources for the chronic RfDs and RfCs for the COPCs at this Site include EPA's Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Tables (HEAST).

G.1.3.2 *Carcinogenic effects*

Table G-3 provides the carcinogenic toxicity data used in the Baseline Risk Assessment. General information about the development and selection of these values is presented below.

Unlike many noncarcinogenic health effects, cancer is believed to originate from a non-threshold effect. Such a "non-threshold"characteristic means that there is essentially no level of exposure that does not pose a some finite possibility of generating cancer growth. Some carcinogenic chemicals can also exhibit systemic toxicity effects.

To evaluate carcinogenic effects, EPA uses a two-part evaluation. First the chemical is assigned a weight-of-evidence classification, followed by calculation of a Carcinogenic Slope Factor (CSF). The CSF can be derived for either oral or inhalation exposures.

TABLE G-3
Carcinogenic Toxicity Data Summary

MEDIUM: SOIL (Current and Future Use - Site Visitor)
Pathways: Soil contact (incidental ingestion, absorption)

Chemical of Potential Concern	US EPA CLASS	Oral SF_o Slope Factor kg-day/kg	Source	Absorption SF_d Slope Factor kg-day/kg	Source
Arsenic	A	1.50E+00	IRIS	1.50E+00	IRIS
2,3,7,8-TCDD Equivalents	B2	1.50E+05	HEAST	1.50E+05	HEAST
Benzo(a)pyrene Equivalents	B2	7.35E+00	IRIS	7.35E+00	IRIS
4,4'-DDT	B2	3.40E-01	IRIS	3.40E-01	IRIS
4,4'-DDE	B2	3.40E-01	IRIS	3.40E-01	IRIS

MEDIUM: GROUNDWATER (Future Use - Offsite Resident)
Pathway: Groundwater use (well water ingestion, inhalation and absorption while showering)

Chemical of Potential Concern	US EPA Classification	Oral SF_o Slope Factor (kg day)/mg	Source	Inhalation SF_i Slope Factor (kg day)/mg	Source	Dermal SF_d Slope Factor (kg day)/mg	Source
Arsenic	A	1.5	IRIS	NA	-	1.5	Extrapolated
Benzene	A	0.055	IRIS	0.027	Extrapolated	0.055	Extrapolated
Chloroform	B2	0.0061	IRIS	0.081	IRIS	0.0061	Extrapolated
p-Dichlorobenzene	C	0.024	HEAST	0.024	Extrapolated	0.024	Extrapolated
1,1-Dichoroethene	C	0.6	IRIS	0.18	IRIS	0.6	Extrapolated
Methylene chloride	B2	0.0075	IRIS	0.0016	IRIS	0.0075	Extrapolated
Tetrachloroethene	B2	0.052	EPA Prov.	0.002	NCEA.	0.052	Extrapolated
Trichloroethene	B2	0.011	EPA Prov.	0.006	NCEA	0.011	Extrapolated
Vinyl chloride	A	1.5	IRIS	0.03	IRIS	1.5	Extrapolated
Bis(2-ethylhexyl) phthalate	B2	0.014	IRIS	0.014	Extrapolated	0.014	Extrapolated
Aroclor (PCB) 1242	B2	1.0 [a]	IRIS	1.0	Extrapolated	1.0	Extrapolated
alpha-BHC	B2	6.3	IRIS	6.3	Extrapolated	6.3	Extrapolated
beta-BHC	B2	1.8	IRIS	1.8	Extrapolated	1.8	Extrapolated
2,3,7,8-TCDD Equivalents	B2	150,000	HEAST	NA	-	150,000	Extrapolated

NA – Not applicable due to volatility.
[a] Central estimate slope factor for high risk and persistence. Applicable to soil and water ingestion.

The weight-of-evidence classification is based upon an evaluation of the available data to determine the likelihood that the chemical is a human carcinogen. The following list shows the EPA cancer classes with an explanation of each (based on the EPA 1986 Cancer Guidelines).

USEPA Weight-of-Evidence
Classification System for Carcinogenicity

Group	Description
A	Human carcinogen
B	Probable human carcinogen
B1	Limited data are available
B2	Sufficient evidence in animals; inadequate or no evidence in humans
C	Possible human carcinogen
D	Not classifiable as to human carcinogenicity
E	Evidence of noncarcinogenicity for humans

The CSF quantitatively defines the relationship between the dose and the response. SFs have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals of concern. The CSFs, which are expressed in units of $(mg/kg\text{-}day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The Slope Factor is generally expressed as a plausible upper-bound estimate of the probability of response occurring per unit of chemical. The term "upper-bound" reflects the conservative estimate of the risks calculated from the CSF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Carcinogenic Slope Factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-animal extrapolation and uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). The Carcinogenic Slope Factors for the chemicals of concern at this Site (Table G-3) were obtained from EPA's Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Tables (HEAST).

It should be noted that no RfDs or CSFs have been derived for dermal absorption, the process by which chemicals move across the skin barrier and into the body. Risks from dermal exposures are evaluated using Oral Absorbed Dose RfDs or Oral Absorbed Slope Factors after dermal exposures are converted to their respective absorbed dose. Dermal exposures were adjusted to absorbed dose estimates by assuming that the contaminants permeate skin at chemical-specific permeability rates. Oral RfDs and CSFs were also adjusted by the appropriate oral absorption rate, which gives an Absorbed Dose RfD or Absorbed Dose CSF. The Dermal Absorbed Dose intakes can then be compared to Absorbed Dose toxicity values, as described in the Risk Assessment Guidance for Superfund (RAGS).

G.1.4 Risk Characterization

The final step in the risk assessment process is the numerical calculation of estimated risk. Table G-4 presents a summary table of the total carcinogenic and noncarcinogenic risks posed by the Arkwright Dump Site. At this stage of risk assessment, the risk calculations include determination of which chemicals actually cause Site risks. These chemicals are referred to as "Contaminants of Concern" (COCs). Appendix B provides the detailed risk calculations for the COCs in the significant (risk-causing) exposure pathways.

As shown in Table G-4, the Site presents long-term risks to human health under both current-use and future-use scenarios. Under both current- and anticipated future-use conditions, the Site property (landfill) presents an estimated total carcinogenic risk level of 1.57 x 10^{-5} to Site visitors, which exceeds EPA's "point of departure" of 1 x 10^{-6} (see discussion below). The carcinogenic risk derives from contact with contaminated soils (dermal absorption, incidental ingestion). The main COCs are dioxins, arsenic, benzo(a)pyrene, and 4,4'-DDE. Under the future use scenario, noncarcinogenic risk is indicated by Hazard Index (HI) values between 142 and 360 for offsite residents who use Site-contaminated groundwater (ingestion, showering, vapor inhalation) as potable water. Carcinogenic risk for the offsite residents is 7.3 x 10^{-3}, which is above the maximum end of the acceptable risk range of 1 x 10^{-4} to 1 x 10^{-6}. The COCs responsible for risk are the VOCs, primarily tetrachloroethene, trichloroethene, 1,1-DCE, and vinyl chloride.

The following paragraphs provide general explanations of the risk numbers, the manner in which they are generated, and EPA's interpretation of the risk results under CERCLA and the NCP. Section G.1.4.2 discusses sources of uncertainty in the calculation of risk estimates.

For chemicals whose effects are carcinogenic, quantifying the risk is done by an additive process that intended to account for a "worst case" scenario, where a person could be exposed through several or all of the possible exposure pathways. Thus, for each exposure pathway (ingestion, inhalation etc.), the cancer risk from each individual contaminant is added together. For each exposure scenario (current use, future use) that has more than one pathway of exposure, all of the pathways are added together to give a "reasonable maximum exposure." The result is expressed as the excess (that is, Site-caused) cancer risk posed by Site contaminants.

The NCP establishes a range of 1 x 10^{-4} to 1 x 10^{-6} as the accepted range for setting, within this range, a limit on lifetime excess carcinogenic risks due to a site. Excess (Site-caused) risk in this range means that between one person in 10,000 (1 x 10^{-4}) and one person in one million (1 x 10^{-6}) will risk developing cancer during a lifetime of exposure. In accordance with the NCP, EPA strives to achieve a 1 x 10^{-6} excess risk level where possible. If the total carcinogenic risk at a site is above this level, by law, EPA can require that remedial actions be undertaken to eliminate or reduce risks.

Noncarcinogenic effects are evaluated by comparing an exposure level over a specified time period (e.g., a lifetime) with a reference dose (RfD) derived for a similar exposure period.

TABLE G-4
Summary of Human Health Risks

Receptors	Hazard Index	Carcinogenic Risk	Primary Source - Pathways	Primary Constituents
Current Land Use				
Adult Site Visitor	<1	1.57 E-05 (1)	Surface Soil - dermal contact and incidental ingestion	Dioxin, arsenic, benzo(a)pyrene, 4,4'-DDE
Future Land Use				
Adult Site Visitor	<1	1.57 E-05 (1)	Surface Soil - dermal contact and incidental ingestion	Dioxin, arsenic, benzo(a)pyrene, 4,4'-DDE
Offsite Adult Resident	142	7.25 E-03 (1)	Groundwater - ingestion of groundwater, inhalation of VOCs and absorption of VOCs during showering	Tetrachloroethene, 1,1-DCE, vinyl chloride, trichloroethene
Offsite Child Resident (Age7-12)	222	7.25 E-03 (2)	Groundwater - ingestion of groundwater, inhalation of VOCs and absorption of VOCs during showering	Tetrachloroethene, 1,1-DCE, vinyl chloride, trichloroethene
Offsite Child Resident (Age 1-6)	360	7.25 E-03 (1)	Groundwater - ingestion of groundwater, inhalation of VOCs and absorption of VOCs during showering	Tetrachloroethene, 1,1-DCE, vinyl chloride, trichloroethene

Notes
(1) Exposure duration = lifetime.
(2) Exposure duration = lifetime. Exposures are presumed to occur beginning as older child (7-12).

An RfD represents a level that an individual may be exposed to that is not expected to cause any negative effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ < 1.0 indicates that a receptor's dose of a single contaminant is less that the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. A summary figure, the Hazard Index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver), or that act through the same mechanism of action within a medium (or across all media) to which a given individual may reasonably be exposed. To obtain a "reasonable maximum exposure," the HQs for all contaminant(s) of concern that effect the same target organ (e.g., liver) within a medium, or across all media, to which a given population may reasonably be exposed are added together to generate the HI. An HI < 1.0 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI > 1.0 indicates that Site-related exposures may present a risk to human health. EPA generally requires that remedial actions be taken at sites which have a current-use or future-use HI that is greater than 1.0.

G.1.4.1 Final Site Contaminants of Concern (COCs)

As noted above, the risk calculations allow determination of which chemicals actually cause risks, i.e. have HIS >1.0 or carcinogenic risk > 1 x 10^{-6}. These chemicals, the Final Site COCs, are presented in Table G-5.

G.1.4.2 Uncertainty Analysis

There are sources of uncertainty in the Baseline Risk assessment. One source is the limited size of the data set obtained in the RI, which is assumed to be representative of Site conditions. Typically, the issue is that this leads to an overestimation of risk, but on a landfill surface with many locations of visible waste and little cover, EPA believes risks from soil are not necessarily overestimated. Exposure parameters used in developing Reasonable maximum Exposure (RME) scenarios involve upper-bound values which are conservative and may lead to overestimation of risk. Among the include toxicity criteria used to estimate risk, cancer slope factors and reference doses (RfDs) both have associated uncertainties that can generate overestimation of risk. In the case of slope factors, the methods for deriving them include extrapolations downward across many orders of magnitude, ususally from animal studies involving high doses. Similarly, RfDs are derived from dose-response studies in animals, from which "no observable adverse effects" levels are modified with "uncertainty factors" (which can be orders of magnitude) that assure that they are protective of human health, often because data from chemical toxicity studies is extremely limited.

No significant data usability issues arose in the RI that impacted the characterization of risk in the Baseline Risk Assessment.

TABLE G-5
Final Site Contaminants of Concern (COCs)

Medium: Soils (surface)	Medium: Groundwater
Exposure pathways: Dermal absorption, incidental ingestion, inhalation	Exposure pathways: Groundwater ingestion; inhalation and absorption during showering
Arsenic Benzo(a)pyrene Dioxins 4,4'-DDE	Benzene 1,1-Dichloroethylene cis-1,2-Dichloroethylene Naphthalene Tetrachloroethylene Trichloroethylene Vinyl chloride Manganese Chlorobenzene Chloroform 1,3-Dichlorobenzene 1,4-Dichlorobenzene Methylene chloride *n*-Propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene Dioxins Alpha-BHC Beta-BHC Arsenic Barium Chromium Iron

G.2 Summary of Ecological Risk Screening Assessment

As part of the RI/FS, the potential for ecological effects from Site contaminants were considered in a Screening Ecological Risk Assessment. EPA and SCDHEC review of the ecological screening indicated that, while there could be some minor degree of ecological impact to Fairforest Creek, the Site cleanup plan will not require a separate action to address ecological concerns. The reasons for this decision are:

(1) The VOCs present in the creek water at the detected levels do not exceed Region 4 ecological screening values, and are therefore not expected to have a significant ecological impact;
(2) Detections other than VOCs were not significant; and
(3) Groundwater actions will be used to reduce or eliminate VOCs in surface water.

G.3 Basis for Action and Summary

As described in Section G.1.4 and shown in Table G-4, the Site presents long-term risks to human health under both current-use and future-use scenarios. Under both current- and anticipated future-use conditions, the Site presents an estimated total carcinogenic risk of 1.57×10^{-5} t Site visitors, which exceeds EPA's "point of departure" of 1×10^{-6}. Noncarcinogenic risk is indicated by HI values between 142 and 360 for future offsite residents who use Site-contaminated groundwater; carcinogenic risk for the future offsite residents is 7.25×10^{-3}, which is above the maximum end of the acceptable risk range of 1×10^{-4} to 1×10^{-6}.

In view of the Baseline Risk Assessment results, EPA has concluded that actual or threatened releases of hazardous substances from the Site, if not addressed by implementing the response action selected in this Record of Decision, may present a continuing imminent and substantial endangerment to public health, welfare, or the environment. The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

H. REMEDIAL ACTION OBJECTIVES

Under Superfund, the selected remedy for a site must protect human health and the environment, and must meet all of the State and Federal requirements which would apply to such an environmental cleanup action. From this starting point, and with input from the Remedial Investigation Report, the Baseline Risk Assessment and the Ecological Screening Risk Assessment, Site-specific remedial action objectives (RAOs) and Remediation Goals were developed in the Feasibility Study.

H.1 Description of RAOs

By defining what the remedy must accomplish, RAOs serve as a design basis for the various response actions and technology types to be considered for use in cleaning up the Site. They form a basis for comparing choices, since they must be achieved if the cleanup is to be successful.

The RAOs established for the Arkwright Dump Site are the following:

Soil:

1. Prevent exposure to, or contact with, soil or landfill contents.
2. Reduce or prevent infiltration of rainwater through waste materials so that generation of leachate, and offsite migration of groundwater, are reduced to the greatest degree possible.
3. Control surface water runoff and erosion from the Site.

Groundwater:

1. Prevent ingestion of groundwater containing contaminant levels above State and Federal MCLs.
2. Reduce or eliminate contaminant concentrations in groundwater moving out from underneath the capped-waste areas, and groundwater which is migrating beyond the property boundaries, in order to restore its potential for productive use as a potable water source.
3. Reduce or eliminate contaminated groundwater discharge to surface water so that there are no exceedances of surface water standards.

H.2 Rationale for RAOs and How Each Addresses Risk

Soil RAOs reflect the basis for employing the Presumptive Remedy at this Site, which is the need to block current and future exposure to long-term risks posed by contact with the landfill wastes. Such action would also control runoff and erosion from the Site into surface water. Action to reduce or eliminate leaching of contamination into groundwater is needed in order to achieve source control on the groundwater contamination, and this would also be accomplished by the Presumptive Remedy of capping.

Groundwater RAOs are intended to both prevent potential human exposure, and to restore all groundwater other than that beneath the capped areas, to its potential beneficial use as a potable water source. Because contaminated groundwater is discharging to surface water, action to reduce the levels of groundwater contamination with VOCs can be expected to reduce, in turn, the levels of VOCs detected in surface water.

In view of this, although surface water is impacted from Site conditions, surface water RAOs were not established. This is based on the very limited degree of impact (one exceedance of a standard) and the fact that any groundwater action would be expected to reduce or eliminate the ongoing groundwater-to-surface water discharge, as described above. Accomplishing the soil and groundwater RAOs will provide appropriate protection for surface water.

At present, potential future use at the Site is undetermined and there are no zoning ordinances or other local restrictions in force that would control or limit its use. The Site Inspection report noted evidence that children were playing on the Site property. The Site is not currently fenced and public access is not physically limited. Therefore, the type of future use scenarios considered in the Baseline Risk Assessment begin with the assumption that the present condition continues; that is, access is not controlled, and there are Site visitors (including children) who cross the Site or visit the Site property at least twice per week during most of the year, excluding three months of winter (no visits).

Because of the uncertainties about future use, the remedy must include the use of institutional controls to limit potential exposure. The most immediate potential, from exposure to landfill contents, will be alleviated once the cap is in place, although some controls will still need to be maintained to protect the integrity of the cap. The specific types of controls to be used will be documented in an "Institutional Controls Plan" as part of the Remedial Design phase of work, to apply to the Remedial Action. Institutional controls are discussed further in Section I.

H.3 Remedial Goals

The Chemicals of Concern (COCs) from the Baseline Risk Assessment (Table G-5) were used, along with State and Federal requirements, to determine Remediation Goals (RGs) for the Site. These are shown in Table H-1. For the soil medium, individual RGs were not established, as recommended in EPA Guidance (OSWER Directive 9355.0-49FS, Sept. 1993). All areas underlain by wastes, unless the waste is excavated and moved, will be capped, thereby eliminating the need for soil RGs. Capping will prevent exposure and isolate the wastes.

As was approved in the FS, RGs were not established for some of the Final Site COCs. In groundwater, an RG was not established for iron, a nutrient element. There were a number of organic compounds for which the detected maximum was below the applicable MCL and below the noncarcinogenic HQ = 1. These included chlorobenzene, 1,3-dichlorobenzene, and *trans*-1,2-

dichloroethene. Of three organic compounds that do not have MCLs, one, n-propylbenzene, was present in a temporary well at HQ < 1. The other two organic compounds (two trimethylbenzenes) were only detected in one temporary well but none of the 12 then-existing Phase I permanent wells, and are not significant. Inorganic contaminants with detections below the MCL and HQ < 1 were barium and chromium.

Among the carcinogenic COCs, arsenic and dioxin maximum values were below the MCL. One detection of methylene chloride at the MCL (of 27 samples) is judged not significant enough to warrant an RG. One PCB (Arochlor 1242) detection from one temporary well is likely an artifact associated with suspended sediment, and is not significant. Finally, alpha-BHC and beta-BHC, two pesticides which have no MCLs, were recorded in two wells at < 1 μg/L each, with corresponding risk levels of between 1 x 10^{-5} and 1 x 10^{-4}. These two compounds were also judged not significant enough to warrant an RG.

TABLE H-1
Remedial Goals

Groundwater

Chemical of Concern	RG (μg/L)	Basis
Benzene	5	MCL
1,1-Dichloroethylene	7	MCL
cis-1,2-Dichloroethylene	70	MCL
Naphthalene	20	Baseline Risk Assessment (1)
Tetrachloroethylene	5	MCL
Trichloroethylene	5	MCL
Vinyl chloride	2	MCL
Manganese	880	Baseline Risk Assessment (2)
Notes 1. This level corresponds to a noncarcinogenic risk HI = 1.0. 2. This level corresponds to a noncarcinogenic risk HI = 1.0.		

I. DESCRIPTION OF ALTERNATIVES

The objective of this section is to provide a brief explanation of the remedial alternatives developed for the Site. In addition to comparing the possible options for capping, the Presumptive Remedy, the Feasibility Study evaluated various technologies that could be used to address contamination in groundwater. Using various combinations of the technologies, seven (7) remedial alternatives were developed. A descriptive summary of each alternative is presented below.

To provide further description, Table I-1 presents a summary of the cost elements, and total costs, of the seven alternatives. The costs shown include "capital costs" and "operations and maintenance (O&M)" costs. Initial up-front construction costs such building a groundwater recovery system or constructing and installing a cap, are capital costs. O&M costs are those necessary to continue the action until cleanup is achieved, based on the estimated time to reach completion. Since these reoccur each year, they are often called "annual O&M costs." Their cost in 2002 dollars, the "net present worth," can be estimated over the total estimated period of the action (30 years) by assuming a discount rate to allow for depreciation. The total of these two types of costs is the "Total Present Worth Cost." A 25% contingency was applied to the capping estimates, and a 15% contingency applied to the groundwater capital costs.

I.1 <u>Summary Descriptions of Remedial Alternatives</u>

Alternative 1 - No Action

- No action other than monitoring of groundwater

  Estimated Capital Cost: $70,000
  Est. Total O&M (Annual / 30 yrs): $40,000 / $470,000
  Est. Total Present Worth Cost: $$540,000
  Estimated Time to Reach RAOs: N/A

The No Action Alternative is a baseline for comparison to other alternatives. No remedial actions are taken to address current or future pathways of exposure; reduce landfill contaminants leaching to groundwater; or address contaminated groundwater moving offsite.

It is assumed that monitoring of groundwater would be conducted. The basic program includes periodic sampling for Site COCs (Table H-1) in all existing Site monitoring wells plus one new monitoring well (16 wells total). It is possible the Remedial Design will identify the need for more wells than these. Figure I-1 shows the 16 wells included for monitoring. Monitoring of six (6) surface water stations is also included, to monitor the effects of treatment on the groundwater discharging to Fairforest Creek. Annual sampling events will be performed.

The NCP requires an evaluation of the remedy every five years. Site groundwater monitoring data are used to support the Five-Year Reviews. No other costs are included.

TABLE I-1
Remedial Alternatives Cost Summary

Alternative Title		Cost (Million $)						
		Total Capital-Capping	Total Capital-Groundwater	Annual O&M Cap	Annual O&M Groundwater	Present Worth O&M Cap	Present Worth O&M Groundwater	TOTAL PRESENT WORTH COST
1	No Action	0	0.07	0	0.04	0	0.47	0.53
2	Institutional Controls	0	0.20	0	0.04	0	0.47	0.66
3	FML Cap and Institutional Controls	4.57	0.10	0.06	0.06	0.68	0.47	5.82
4	FML Cap, Institutional Controls and MNA	4.57	0.12	0.06	0.06	0.68	0.71	6.08
5	Soil Cap, Institutional Controls and Groundwater Recovery	3.45	0.31	0.06	0.23	0.68	2.84	7.28
5A	FML Cap. Institutional Controls and Groundwater Recovery	4.57	0.31	0.06	0.18	0.68	2.26	7.82
6	FML Cap, Institutional Controls and Enhanced Biodegradation	4.57	0.29	0.06	0.04	0.68	0.51	6.05

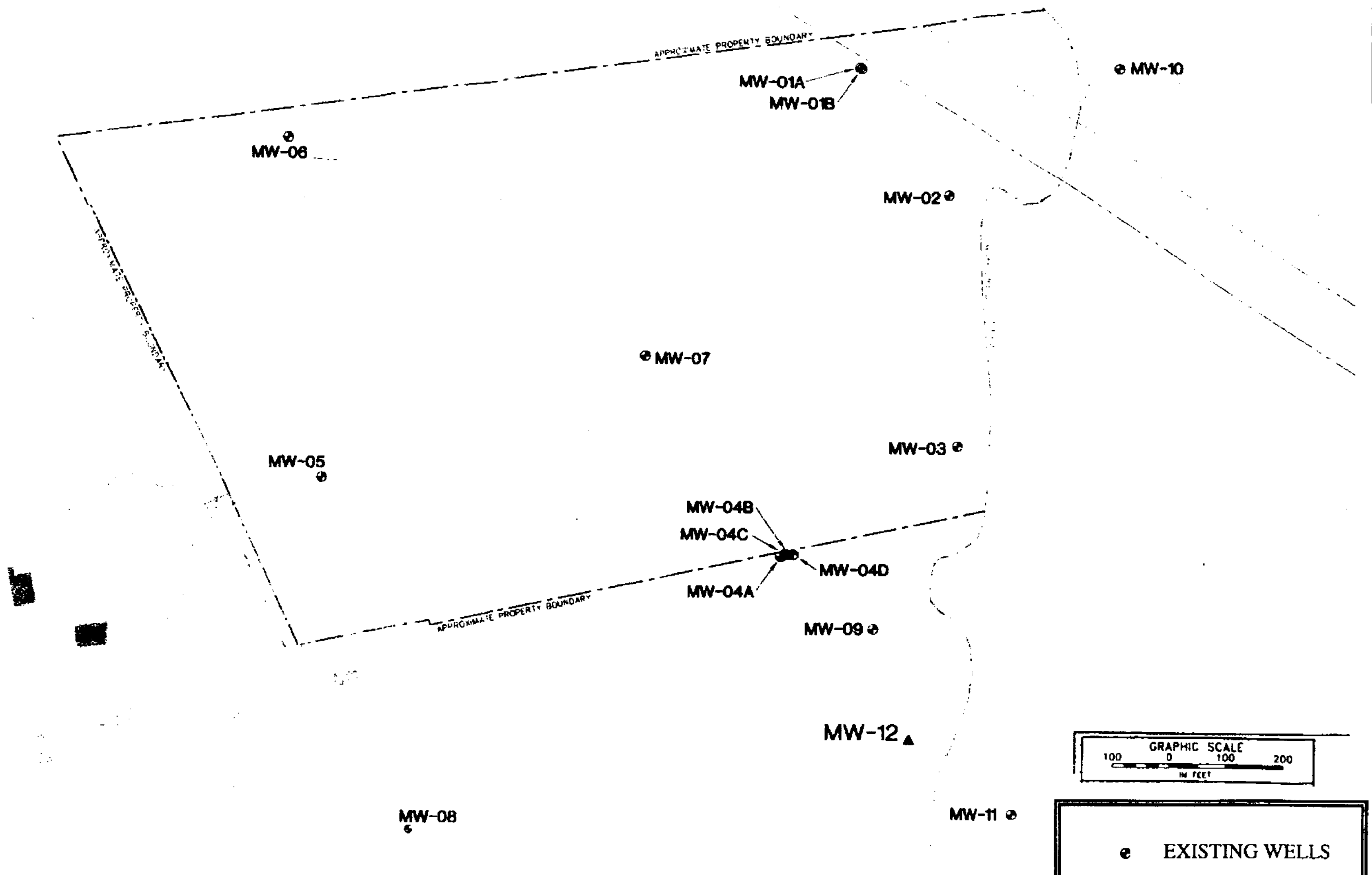


FIGURE I-1. Groundwater Monitoring Program Wells

Alternative 2 - Institutional Controls
- Institutional controls to limit Site use
- Monitoring of groundwater
- Fencing installed around Site perimeter

Estimated Capital Cost: $200,000
Est. Total O&M (Annual / 30 yrs): $40,000 / $470,000
Est. Total Present Worth Cost: $670,000
Estimated Time to Reach RAOs: N/A

This alternative uses institutional controls and one engineering control (fencing) to limit access to the Site, thereby preventing or limiting exposure to contaminated surface soils on the former landfill. Institutional controls such as signs, easements, covenants, deed notices or deed restrictions, and the regulatory and advisory role the State environmental agency (SCDHEC) fulfills under the water well permitting process, are used to prevent exposure to contaminated groundwater in the future. No actions are taken to intercept migrating groundwater (southeast, northeast) where it has migrated offsite, or prevent its continued release to Fairforest Creek.

Finally, annual groundwater monitoring is included as described above for the No Action Alternative (one annual sampling event). Here and in the following alternatives, a part of the groundwater capital cost ($100,000) covers installation of one additional monitoring well, in addition to completion of the associated office/field work (permits, oversight, report preparation) necessary to accomplish the monitoring effort.

As with the No Action Alternative, the time needed to reach RAOs cannot be estimated, since RAOs will not be met.

Alternative 3 - FML Cap and Institutional Controls
- Institutional controls to limit Site use
- Construction and installation of an Flexible Membrane Liner (FML) cap
- Monitored Natural Attenuation (MNA) of groundwater contamination
- Monitoring of groundwater

Estimated Capital Cost: $4,670,000
Est. Total O&M (Annual / 30 yrs): $120,000 / $1,150,000
Est. Total Present Worth Cost: $5,820,000
Estimated Time to Reach RAOs: Soil 12-15 months, Groundwater N/A

Alternative 3 adds the construction of a multi-layer FML cap over the landfill area to prevent risks to human health. A Flexible Membrane Liner (FML) cap uses man-made materials such as twin geotextile membranes with a clay liner between them, or sheeting of various plastics (HDPE, LDPE, PVC, etc.) to achieve low permeability, i.e. to limit infiltration of precipitation (rainwater). Compacted soil is used in the base layer of the cap to stabilize the wastes and provide the best possible foundation for the overlying drainage layer and low-permeability layer(s).

Institutional controls (as described under Alternative 2) are used to prevent exposure to contaminated groundwater in the future. The alternative is "limited action" in the sense that no actions are taken to intercept migrating groundwater or prevent its continued release to Fairforest Creek.

Capping, the Presumptive Remedy, is a containment action in that it physically isolates the wastes, thus blocking potential health risks from the soil exposure pathway. However, capping will achieve some degree of source control on the waste responsible for leaching contamination to groundwater.

In this alternative and all those following, capping includes the following components and assumptions. All areas underlain by wastes will be capped, or the waste will be moved and consolidated as necessary, so that all wastes remaining onsite are capped. The volume of landfilled materials is estimated to be approximately 745,000 cubic yards. In accordance with RCRA Subtitle D and State of South Carolina Solid Waste Landfill regulations, which are relevant and appropriate for this action (see Section M), final grade slopes will achieve a slope of 3:1 for slope stability, unless otherwise approved by EPA and South Carolina during the Remedial Design. The top of the landfill will be graded relatively flat but with sufficient slope to allow water to run off the landfill cover. Nearby soil appears to be available for use as cover material, and RI testing indicates it can be compacted to a permeability of 1×10^{-5} cm/sec. Potential damage to the cover over the waste will preclude construction of a building on all portions of the landfill where the cover is present. Contaminated soil and waste in the small, segregated area on the northeast corner of the property (Figure E-4) will be moved to the main landfill area, and consolidated and covered with the other wastes. A passive landfill gas collection system will be installed under the cap. Current data indicate that landfill gases will not require active treatment.

To construct the cap, waste will be moved and consolidated as necessary to bring the contents to within the boundaries shown on Figure I-2. The final footprint of the capped enclosure will be determined in the Remedial Design. The entire landfill contents will be covered with soil, in lifts, in thicknesses required by the relevant and appropriate State and Federal ARARs. The soil lifts will be compacted to the permeability required by the ARARs (generally, a criterion of 1×10^{-5} cm/sec unless otherwise approved in the Remedial Design). An FML (Flexible Membrane Liner) will be installed over the compacted soil. The FML will be covered with soil layers constructed in accordance with the ARARs, and a vegetative cover (root zone) will be established on the cover. The additional root zone is intended to enhance evapotranspiration. (Note: Alternative 5 does not include the FML cap, but rather a compacted native soil cap. See below.)

The FS demonstrated that for negligible increased costs, a potential future road corridor can be created along the old ridgeline in the western portion of the Site (Figure I-2). To accomplish this, waste can be removed from along a 100-foot-wide corridor. Removal of the waste reduces the total area of the cap by about 1½ acre. The radii of the turns meet the Spartanburg County

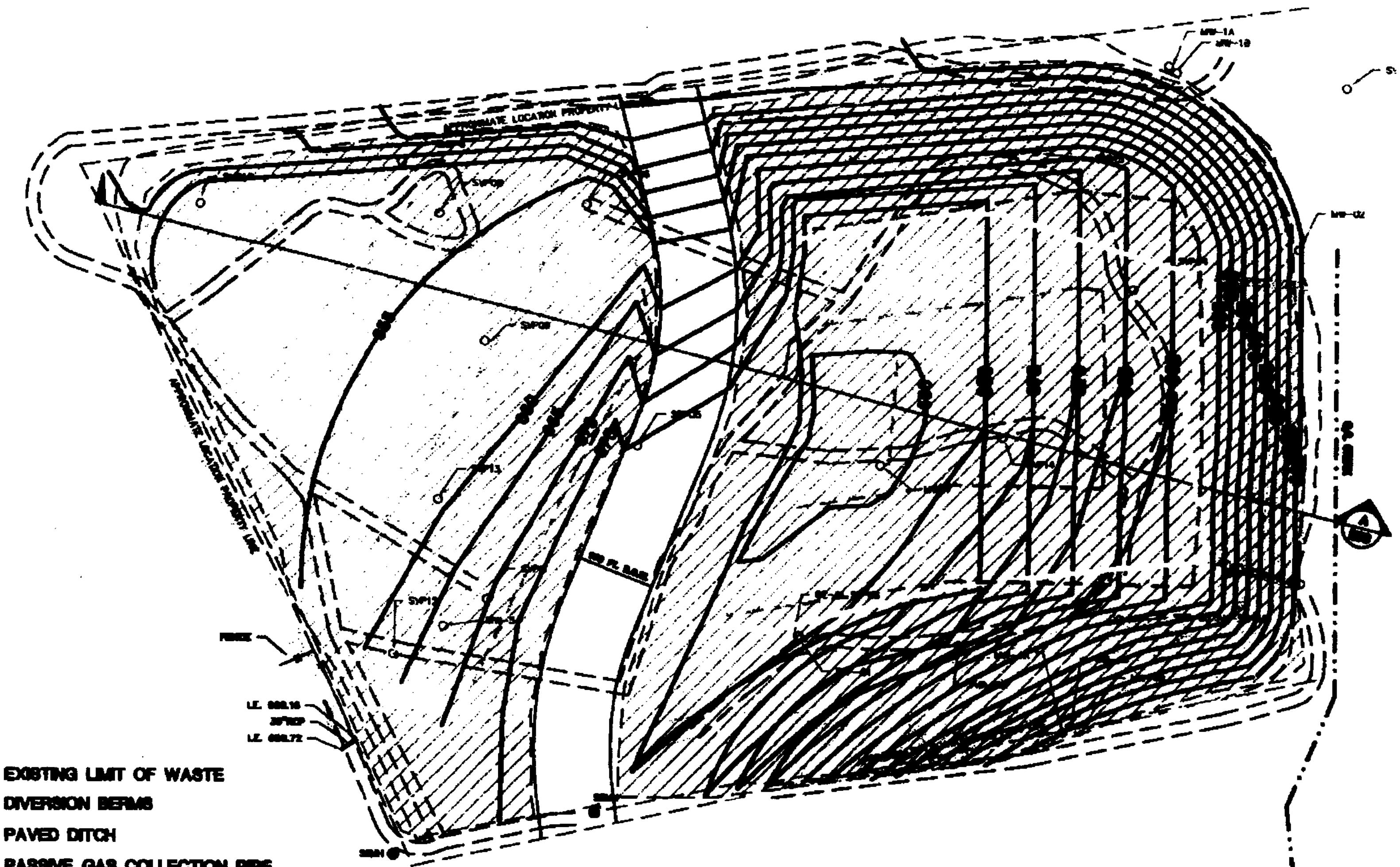


FIGURE I-2. Presumptive Remedy - Cap

specification for a 45 mile per hour speed limit. While not required by EPA and SCDHEC, this assumption was used in the FS. Unless the Remedial Design determines otherwise, capping will include moving and consolidating the wastes in order to allow the 100-foot cleared, unoccupied road corridor to remain onsite.

The main capital cost is for the cap alone. The remaining small capital cost ($100,000) covers groundwater monitoring. Groundwater monitoring (twice annually), as described under Alternative 1, is included. Since no measures are employed to intercept groundwater or mitigate its discharge to surface water, RAOs cannot be achieved.

Alternative 4 - FML Cap, Institutional Controls and MNA
- Institutional controls to limit Site use
- Construction and installation of an FML cap
- Monitored Natural Attenuation of groundwater contamination
- Monitoring of groundwater

> Estimated Capital Cost: $4,690,000
> Est. Total O&M (Annual / 30 yrs): $120,000 / $1,390,000
> Est. Total Present Worth Cost: $6,080,000
> Estimated Time to Reach RAOs: Soil 12-15 months, Groundwater 30 yrs

In addition to the installation of a FML cap over the landfill area, as described above for Alternative 3, Alternative 4 uses Monitored Natural Attenuation (MNA) is to achieve cleanup of contaminated groundwater. Ongoing biological degradation of the contaminants is carefully monitored to ensure that the decrease in contaminant levels is occurring at a steady, predictable rate.

Monitored Natural Attenuation refers to the reliance on natural processes to achieve remediation of groundwater within a time frame that is reasonable compared to other methods. The processes that are at work include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These *in situ* processes include biodegradation; dispersion; dilution; sorption; volatilization; and chemical or biological stabilization, transformation, or destruction of contaminants. EPA has developed an MNA protocol that provides a framework within which the degradation of contaminants is carefully monitored. MNA involves implementing an EPA-approved framework, or protocol, that prescribes in detail the required number and placement of monitoring wells, sampling requirements (additional chemical analyses), and the accepted methods of measuring successful performance. For most sites, the MNA protocol involves more monitoring wells to demonstrate that MNA is, in fact, proceeding successfully. As noted in Section E.2.2, RI data suggest that ongoing biological degradation of the Site groundwater COCs is occurring.

Besides the cap, significant groundwater capital costs ($120,000) include the addition of 5 new wells, more wells than Alternatives 2 and 3. It is possible more than 5 would be necessary. O&M costs include monitoring, but are less than the other remaining alternatives (Alternatives 5, 5A, 6).

Groundwater monitoring (twice annually), as described under Alternative 1, is included. However, three (3) additional wells (beyond the 16 wells for monitoring as described under Alternative 1) are assumed to be necessary to monitor the attenuation processes. For comparison purposes it is assumed that RAOs can be reached in 30 years, a comparable timeframe to the other alternatives, but this would have to be verified by a Treatability Study as part of the Remedial Design.

Alternative 5 - Soil Cap, Institutional Controls and Groundwater Recovery
- Institutional controls to limit Site use
- Construction and installation of a native soil cap
- Construction and operation of a groundwater pump-and-treat system
- Monitoring of groundwater

Estimated Capital Cost: $3,760,000
Est. Total O&M (Annual / 30 yrs): $290,000 / $3,520,000
Est. Total Present Worth Cost: $7,280,000
Estimated Time to Reach RAOs: Soil 12-15 months, Groundwater 30 yrs

Alternative 5 uses groundwater recovery and treatment to address contaminated groundwater. Groundwater recovery is often called "pump-and-treat" because the informal term describes in brief what is done when using this treatment technology. Contaminated groundwater is captured using a network of specially-constructed wells, and the water is then treated using one or more methods to remove the contaminants. A common treatment method for VOCs is "air stripping," and this type treatment is used in Alternatives 5 and 5A. Treated water is disposed of through discharge to surface water under permit, to a publicly-owned treatment works, into injection wells if permitted, or by other means. As presented in the FS, the most feasible option at present is to discharge treated groundwater to a publicly-owned water treatment facility.

Figure I-3 illustrates a plausible configuration of two pumping-well lines likely to be sufficient to contain the zone of contaminated groundwater migration at the two Site areas where this appears to be occurring. Alternative 5, with the soil cap, assumes a greater well yield (10 gpm) compared to Alternative 5A (7 gpm).

Pump-and-treat methods can be expected to control the offsite movement of contaminated groundwater. Therefore, this alternative includes a compacted-soil cap without a synthetic liner component (plastic or other man-made materials). A soil cap is expected to reduce infiltration by about 25%, while a FML cap may provide a >98% reduction. The rationale for the soil cap is that a large reduction in the amount of rainwater percolating through the waste is not as crucial if the pump-and-treat system properly captures and treats the water anyway.

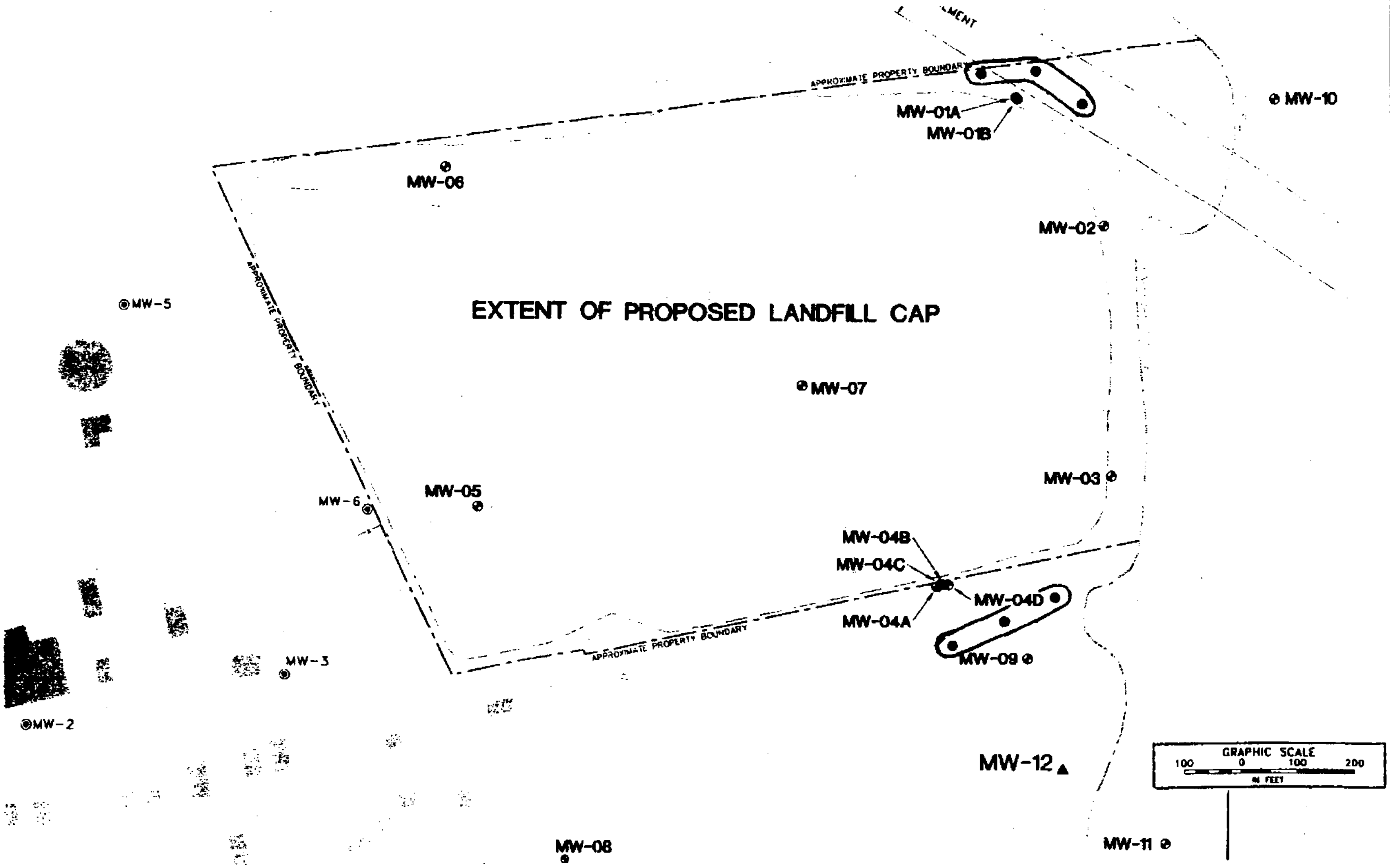


FIGURE I-3. Alternatives 5/5A Groundwater Recovery Systems

Significant capital costs ($310,000) beyond the capping cost are required for building the pump-and-treat system. Annual O&M cost for this system are high, making this alternative the most expensive to maintain over the long term. Groundwater monitoring (twice annually), as described under Alternative 1, is included. The estimated time for achieving Site RAOs and performing O&M, may be 30 years or greater.

Alternative 5A - FML Cap, Institutional Controls and Groundwater Recovery

- Institutional controls to limit Site use
- Construction and installation of an FML cap
- Construction and operation of a groundwater pump-and-treat system
- Monitoring of groundwater

Estimated Capital Cost: $4,880,000
Est. Total O&M (Annual / 30 yrs): $240,000 / $2,940,000
Est. Total Present Worth Cost: 7,820,000
Estimated Time to Reach RAOs: Soil 12-15 months, Groundwater 30 yrs

This alternative is identical in all respects to Alternative 5, except that a FML cap is constructed over the waste rather than a compacted-soil cap. The capital costs for the FML cap are higher than the Alternative 5 soil cap by approximately $1,120,000, or roughly 25%. Similarly high capital costs are expected, and a similar very-high O&M cost is projected. Thirty years or more will be required to reach the RAOs.

Alternative 6 - FML Cap, Institutional Controls and Enhanced Biodegradation

- Institutional controls to limit Site use
- Construction and installation of an FML cap
- Implementation of enhanced biodegradation processes for groundwater
- Monitoring of groundwater

Estimated Capital Cost: $4,860,000
Est. Total O&M (Annual / 30 yrs): $100,000 / $1,170,000
Est. Total Present Worth Cost: $6,030,000
Estimated Time to Reach RAOs: Soil 12-15 months, Groundwater 30 yrs

Enhanced Biodegradation represents a group of closely-related methodologies for treating contaminated groundwater in-situ, i.e. in place. group of related that enhance microbial degradation of chlorinated organics by providing, to the indigenous microbial populations, a substrate that furthers their degradation of the organic compounds. Substantial reductions in contaminant levels have been achieved at many sites.

There are a number of process options, relating to the particular substrate used; one or more of them could be used. One representative of this group of technologies is Hydrogen Release

Compound, or HRC. HRC is a proprietary, environmentally safe polylactate ester, such as sorbitol polylactate ester, which has been formulated for the slow release of lactic acid upon hydration in groundwater. The lactic acid produces conditions favorable to organisms that carry out anaerobic reductive dechlorination of chlorinated VOCs such as tetrachloroethene and trichloroethene, both of which are present at the Site. HRC is typically injected into the subsurface by pumping the material, which the vendor describes as having the viscosity of honey, using direct push methods or by drilling. The material can be injected into bedrock fractures by pumping into wells drilled into the rock. This bedrock-injection technology has been implemented at a few sites, but is less well demonstrated, however.

Other similar process options for enhanced biodegradation treatment include injection of molasses, and injection of vegetable oil. The basic processes, requirements and limitations are the same.

These bioremediation methods rely heavily on injection of the amendment. A Treatability Study will be necessary at the start of Remedial Design to investigate (1) delivery strategies into the fractured bedrock aquifer, (2) comparative performance of the different options in relation to the geochemistry of the groundwater, and (3) methods for demonstrating effectiveness of the treatment.

The locations for the injection treatments would likely be determined by the Site wells showing the highest contaminant levels, and focused on the source area along the toe of the landfill. To illustrate the general process, the HRC or other treatment solution would be injected into the subsurface downgradient of the landfill in the areas where the concentrations of chlorinated VOCs are highest. The HRC is in a gel form that would be injected using a direct hydraulic push technology, such as GeoProbe®. A column of HRC would be injected from probe refusal, which is presumably the top of bedrock, to the top of the water table. The treatment strategy would be revised and further refined as necessary during the Remedial Design based on Treatability Study work.

Injection into bedrock is likely to be more problematic and would be implemented based upon the results of a pilot-scale treatability study for one or more of the process options. Thus Alternative 6 includes such a treatability study. Its purposes would include evaluating the effectiveness of the process options, investigating delivery strategies for bedrock, and gathering necessary design information. The treatment would be targeted to the areas around the toe of the landfill that were found to be significant sources of contaminants to the groundwater. The areas to be addressed by this alternative are shown in Figure I-4. Treatability study results would be considered in selecting the actual locations where the treatment would be performed.

As with all of the alternatives, there are uncertainties about costs for Alternative 6. For example, the treatment may be implemented only once; or it may be done periodically, with monitoring periods ongoing between treatments, resulting in additional modest O&M costs. Additionally,

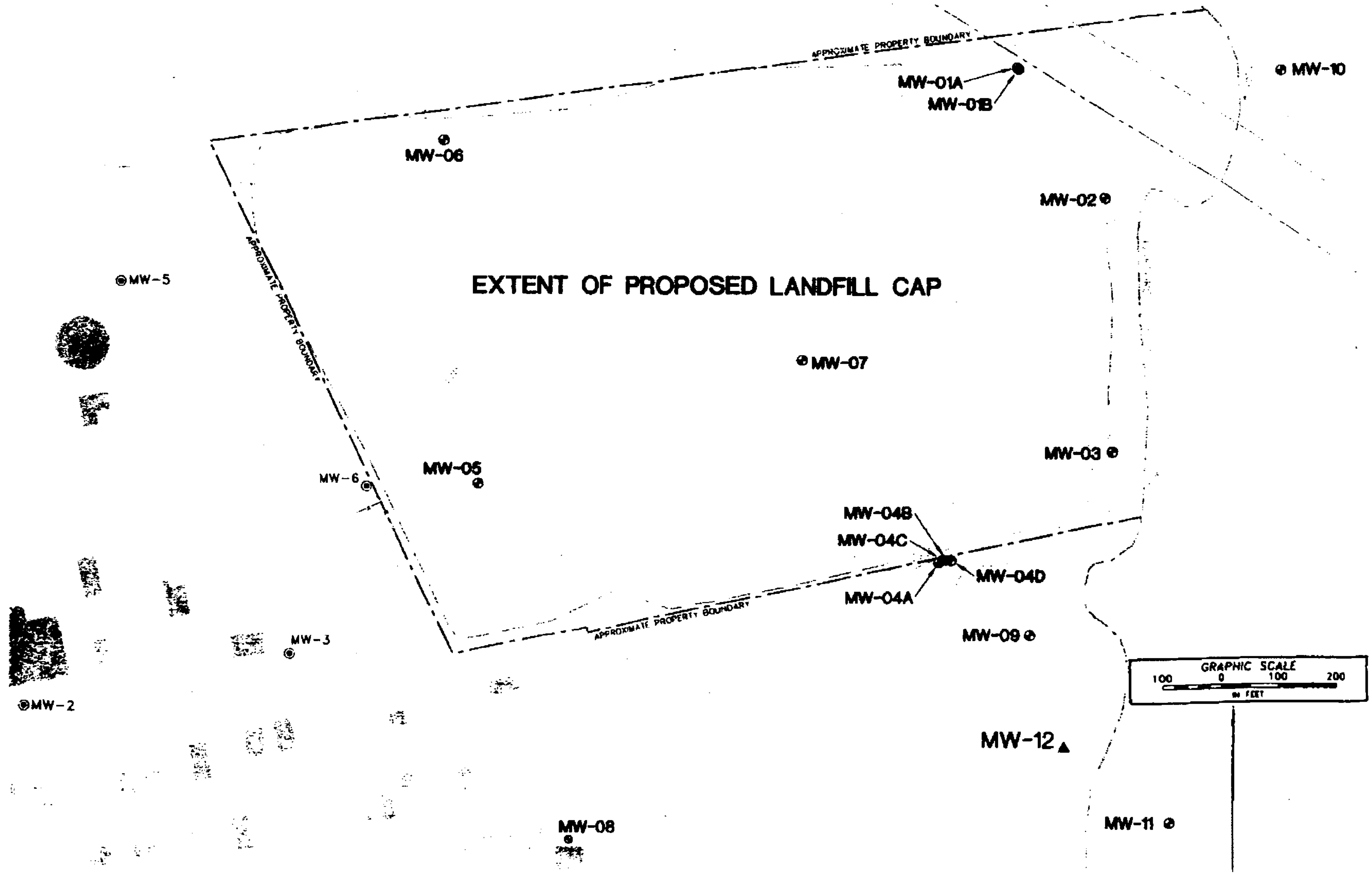


FIGURE I-4. Alternative 6 Enhanced Biodegradation Treatment Areas

depending on the effectiveness of the treatments, the time required to reach RAOs may be significantly shorter than 30 years. For comparison, however, a 30-year period is assumed. Groundwater monitoring (twice annually), as described under Alternative 1, is included; however, it also includes one additional well beyond those described for monitoring under Alternative 1 above.

I.2 Common Elements and Distinguishing Features of the Alternatives

This section presents information highlighting similarities and distinctions among the alternatives. These characteristics provide additional basis for the comparative analysis made in Section J. For ease of reference in the following discussion, the titles and components of the seven alternatives are listed here.

Alternative 1 –	No Action
Alternative 2 -	Institutional Controls
Alternative 3 -	FML Cap and Institutional Controls
Alternative 4 -	FML Cap, Institutional Controls and MNA
Alternative 5 -	Soil Cap, Institutional Controls and Groundwater Recovery
Alternative 5A -	FML Cap, Institutional Controls and Groundwater Recovery
Alternative 6 -	FML Cap, Institutional Controls and Enhanced Biodegradation

A number of State and Federal applicable or relevant and appropriate requirements (ARARs) apply to all of the alternatives that include the Presumptive Remedy (capping), i.e., all alternatives besides No Action (Alternative 1) and Institutional Controls (Alternative 2). The main ARARs applicable to capping activities are the RCRA Subtitle D landfill requirements (40 CFR Part 258), and the State of South Carolina Solid Waste Management Regulations for municipal landfills (Reg. 61-107.258). Clean Air Act requirements are not foreseen for the passive venting planned under the capping alternatives, based on Site data. Federal Occupational Health and Safety Administration (OSHA) regulations will govern onsite work during cap construction. Since onsite observations indicate that the landfill has surface runoff and soil erosion going into Fairforest Creek, the capping action plays a part in meeting the intent of meeting the Federal and State Ambient Water Quality Criteria (AWQCs) and the Wetlands Protection Act (Executive Order 11990 and CWA Section 404), under the Clean Water Act, by preventing such erosion.

For the same reasons, the storm water provisions of the National Pollutant Discharge Elimination System (NPDES) are applicable to cap construction. Finally, since the capping action will involve land along Fairforest Creek and could affect the creek itself, Executive Order 11988 (Floodplain Management) and the Fish and Wildlife Coordination Act (40 CFR Section 6, Part 302), respectively, will apply.

Similarly, the major ARARs for the groundwater components of the alternatives apply to all of the alternatives besides No Action (Alternative 1), except for three which concern only the groundwater recovery alternatives (Alternatives 5 and 5A). The National Primary Drinking Water Standards from the Safe Drinking Water Act, are relevant and appropriate because the aquifer, by State and EPA classification, is a potential drinking water source. As with the cap, Federal Occupational Health and Safety Administration (OSHA) regulations will govern onsite work during onsite activities for the groundwater actions, whether sampling, construction of a recovery system, sampling wells, performing injection treatments, or others.

The ARARs that are different include portions of the Clean Water Act and the Clean Air Act. Clean Air Act requirements could be applicable to the treatment device (air stripper) used in Alternatives 5 and 5A, which produces vapor emissions from treating the water, although the FS concludes this would be unlikely. If the treated water is to be discharged to a surface water body, the wastewater provisions of NPDES (Clean Water Act) are applicable. Finally, those State and Federal regulations governing the transport and disposal of hazardous wastes (Federal Resource Conservation and Recovery Act (RCRA), SC Reg. 61-79) would apply if the treatment process generates hazardous wastes.

One common element among Alternatives 2 through 6 (all except the No Action Alternative) is the use of institutional controls to control Site property use. The need for such controls is foreseen, given that access to the Site is unrestricted, legal decisions about future use have not yet been made, and there are no zoning ordinances in place. According to Spartanburg County, zoning ordinances are not likely to be instituted in the foreseeable future. Specific local controls which may prove necessary could include easements, covenants, deed notices, or deed restrictions. These may require action at the County government level. The state health agency (SCDHEC) has an advisory role to the public concerning installation of potable water wells, and this will also assist in preventing the possibility of exposure. A certain degree of control may be attained if the Site property were purchased by the City, County, or nonprofit entity (covenants or easements). At present, which specific actions are necessary is difficult to foresee. Therefore, implementing institutional controls effectively will require significant planning in the Remedial Design phase, to include an " Institutional Controls Plan" as part of the design. EPA expects to work with the landowner, local authorities, and the community to ensure that Site use remains consistent with the remedy.

Institutional controls may also be necessary in the areas where Site groundwater contamination has migrated offsite. To the southeast, Site contaminants are present at MW-9 and discharge to Fairforest Creek. To the northeast, the VOC detections in groundwater feeding Fairforest Creek (samples MP-80 and MP-96, Table E-3) probably also represent contaminated Site groundwater moving offsite, under the former IMC Fertilizer plant property. Control measures would be intended only to restrict the use of groundwater. The IMC Site has an ongoing RI/FS in progress, and the need for any controls in the near term is unlikely. The " Institutional Controls Plan" noted above will address offsite properties as necessary.

All of the capping alternatives (Alternatives 3 through 6) include an engineering control, fencing installed around the Site perimeter (as noted for Alternative 2). Although included, it is considered optional, to be used if necessary for construction security. The one significant difference among the alternatives that include capping concerns the use of a synthetic liner. Alternative 5 (Presumptive Remedy (Soil Cap), Institutional Controls, and Groundwater Recovery) includes a cap constructed using native soil that is compacted to achieve an appropriate permeability criterion. Based on State Solid Waste Landfill Regulations, the criterion is 1×10^{-5} cm/sec or less. In all other alternatives, a Flexible Membrane Liner (FML) is installed between the soil layers to achieve a superior reduction in permeability.

One common element of those alternatives which include groundwater components (Alternatives 4, 5/5A, and 6) is the focus the treatment on VOCs, rather than the one inorganic Site groundwater COC, manganese. Manganese is believed to be a product of the reducing (oxygen-depleted) environment in and around VOC-bearing water that is being microbially degraded. Biological degradation of the chlorinated organics (Alternatives 4, 6) or their removal (Alternatives 5, 5A) represents the best and perhaps only ways to allow dissolved oxygen levels to rebound enough so that manganese is no longer produced. For this reason, manganese will not require a separate treatment component from those aimed at VOCs.

The time periods for the different alternatives to achieve Site RAOs (Section H-1) have a significant degree of uncertainty associated with them, but this is entirely due to uncertainties regarding the groundwater RAOs. For Alternatives 1 (No Action) and 2 (Institutional Controls), the soil RAOs and groundwater RAOs will not ever be achieved, since soil risks on the landfill will remain and no groundwater action will be taken.

Capping, whether using native soil only (Alternative 5) or the FML liner (Alternatives 3, 4, and 5A), will require approximately 12-15 months to design and construct. Upon cap construction, the RAOs for soil will be met. Thus both Alternative 3, which has the FML cap but uses only institutional controls to address groundwater, and Alternative 4, which has the cap and employs MNA to address groundwater, will meet soil RAOs (only) in 12-15 months from Remedial Design start.

The time period required for achieving groundwater RGs (and hence RAOs) is uncertain and could be decades. The source, in the landfill, cannot practicably be removed, and the eventual scale of the reduction in leachate generation caused by emplacement of the cap is unknown. For this reason, a 30-year monitoring period was assumed to apply to all alternatives. Since meeting Site RAOs requires meeting the groundwater RAOs, the uncertainties described below apply to Alternatives 3, 4, 5, 5A, and 6.

Alternatives 3 and 4 use institutional controls and MNA, respectively, to address groundwater. Neither of these Alternatives involves actively intervening to change the extent, degree, or migration of the existing groundwater contamination. Although the completion of a cap over the wastes will have some effects on underlying groundwater chemistry, and even though the character of the effects could be positive overall if naturally-occurring biodegradation processes

are expanded in the altered groundwater, there is still no basis to predict how much time will be required to reach RAOs for these two alternatives.

Alternatives 4 (using MNA), 5 and 5A (groundwater recovery) and 6 (enhanced biodegradation) will require similar time frames, probably 6 to 9 months, to design the remedial action (5, 5A) or to plan it using treatability studies (4, 6). All four alternatives include the cap, which as noted above, may have positive effects on the Site's groundwater. However, the expected time periods required to achieve RAOs for these four alternatives are difficult to predict and could be very long, even decades. The following three points bear on this similarity.

1. For Alternatives 5 and 5A, which use groundwater recovery (pump-and-treat), the reasons for the expected lengthy time period relate to two factors. First, the contamination is in fractured bedrock, which often limits and controls where and to what degree pumping is effective. Secondly, there are inherent chemical inefficiencies ("performance dropoff" and "rebound" effects) known from experience with other groundwater recovery and treatment systems, that can affect pump-and-treat remediation.

2. For Alternative 4, using MNA, as noted above, there is no basis currently for predicting how much time will be required to reach RAOs. In the FS and this ROD, MNA is given the benefit of the doubt, and an assumed 30-year period is used for comparison.

3. For Alternative 6, the uncertainty about the length of time that will be required relates to the degree of effectiveness achieved by the insitu biological enhancement treatments. If the treatment is effective in any degree, however, then the time period would be shortened in comparison to MNA.

Alternatives 4 (FML cap and MNA) and 6 (FML cap and enhanced biodegradation) are distinct from the other two groundwater recovery alternatives (5, 5A) in their requirement that a groundwater treatability study be performed as part of the Remedial Design. The study would be initiated after the cap is installed, due to the expected chemical changes to the underlying groundwater characteristics that will be caused by cap installation (reduced oxygen content, altered redox characteristics, and other effects resultant from permeability reduction and blockage of infiltration).

As shown in Table I-1, the alternatives have a range of costs. The No Action (Alternative 1) is the least costly, followed by the institutional controls only alternative (Alternative 2). The total costs for Alternatives 3, 4, 5, 5A, and 6, which all include a cap and a groundwater component, range from $5.82 million to $7.82 million.

The two groundwater recovery alternatives (5 and 5A) are distinguished by having the highest capital costs, although Alternative 6 (enhanced biodegradation) is within 7%. The Alternative 6 cost estimate includes only the initial application of HRC or treatment solution; if additional treatments proved necessary, each one would add $100,000. Alternative 2 (institutional controls only) includes a fence around the Site, which doubles its groundwater capital cost compared to Alternative 3 (FML cap and institutional controls), which is identical otherwise with respect to groundwater.

The annual groundwater O&M cost, and the associated net present worth cost, is much higher for each of the two groundwater recovery alternatives in comparison to Alternatives 4 or 6.

Each alternative was evaluated in the FS without a built-in contingency remedy. Should a remedy prove ineffective, EPA believes that the uncertainties about all of the available groundwater components would require that a full review and consequent ROD amendment be completed.

The enhanced biodegradation included as the groundwater component in Alternative 6 should be considered an "innovative technology," in view of the limited number of sites in treatment and limited use in fractured bedrock.

I.3 Expected Outcome of Each Alternative

Under the No Action alternative, the Site would remain as is. Based on the potential future land use scenario, Site visitors and nearby groundwater well users would continue to have long-term health risks. Groundwater contamination escaping to adjoining properties and Fairforest Creek would continue.

Under Alternative 2, Institutional Controls, the Site would be fenced but otherwise left as is. Long term health risks from soil would remain, given the poor condition (and in many places absence) of the soil cover. Groundwater contamination escaping to adjoining properties and Fairforest Creek would continue.

TABLE I-1
Remedial Alternatives Cost Summary

Alternative Title		Cost (Million $)						
		Total Capital-Capping	Total Capital-Groundwater	Annual O&M Cap	Annual O&M Groundwater	Present Worth O&M Cap	Present Worth O&M Groundwater	TOTAL PRESENT WORTH COST
1	No Action	0	0.07	0	0.04	0	0.47	0.53
2	Institutional Controls	0	0.20	0	0.04	0	0.47	0.66
3	FML Cap and Institutional Controls	4.57	0.10	0.06	0.06	0.68	0.47	5.82
4	FML Cap, Institutional Controls and MNA	4.57	0.12	0.06	0.06	0.68	0.71	6.08
5	Soil Cap, Institutional Controls and Groundwater Recovery	3.45	0.31	0.06	0.23	0.68	2.84	7.28
5A	FML Cap, Institutional Controls and Groundwater Recovery	4.57	0.31	0.06	0.18	0.68	2.26	7.82
6	FML Cap, Institutional Controls and Enhanced Biodegradation	4.57	0.29	0.06	0.04	0.68	0.51	6.05

Alternatives 3 through 6, which all include a cap, would leave the Site property usable in the manner described in Section F. Site monitor wells will be present but should not interfere with use.

Groundwater use in the nearby area is for non-potable uses. Beneficial use of the aquifer for potable water in the future would be restored under Alternatives 4, 5, 5A, and 6, although the time necessary to achieve cleanup is uncertain.

J. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The National Contingency Plan (NCP) requires the analysis of remedial alternatives according to nine overall criteria. Descriptions of these, and a narrative evaluation of the strengths and weaknesses of the alternatives, are presented in this section of the ROD.

The initial evaluation is made according to two threshold evaluation criteria:
1) overall protection of human health and the environment; and 2) compliance with ARARs. An alternative must meet these two criteria to be eligible for selection as the remedy.

Remaining alternatives are then subjected to a comparative analysis based upon five primary balancing criteria: 1) long-term effectiveness and permanence; 2) reduction of toxicity, mobility, and volume through treatment; 3) short-term effectiveness; 4) implementability; and 5) cost. These criteria allow EPA to consider the trade-offs in these aspects of performance, and make judgements about the overall case for, and against, each alternative.

Finally, two modifying criteria are considered: 1) state/support agency acceptance, and 2) community acceptance. These criteria are important and may cause EPA to alter its preferred remedy choice.

In the Feasibility Study, all potential methods and technologies for remediation of groundwater were developed and then screened based upon the general categories of effectiveness, implementability, and cost. Remaining technologies were then eligible for assembling, with the Presumptive Remedy (capping), into remedial alternatives. Similarly, capping options were screened, and those passing screening were assembled in a logical manner with the groundwater actions. Seven (7) remedial alternatives were assembled, which were then analyzed and compared according to the nine NCP criteria.

J.1 Threshold Criteria

J.1.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

All of the alternatives except Alternative 1 (No Action) can, if implemented properly, achieve some degree of protection of human health and the environment. The No Action alternative, which does not address potential exposure pathways or contaminated media, is not considered further in this analysis.

Alternatives 2 and 3 rely on institutional controls to eliminate risks from groundwater, but do not include actions to prevent or lessen groundwater discharge to surface water. Thus no additional protection of the environment beyond the current situation is provided. The degree of protection to both human health and the environment is judged inadequate, and these two alternatives are not considered further.

Alternatives 4, 5, 5A and 6 are expected to provide adequate protection of human health and the environment. All four alternatives include a cap to eliminate potential exposure to Site soils and landfill wastes, and minimize leaching to groundwater. Alternatives 5 and 5A use groundwater recovery and treatment systems to reduce groundwater contamination and eliminate risks from groundwater. Alternative 4 employs MNA to reduce groundwater contaminant levels and remove groundwater risks, while Alternative 6 uses enhanced biodegradation to accomplish this.

J.1.2 Compliance with ARARs

Section 121(d) of CERCLA and NCP § 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs", unless such ARARs are waived under CERCLA Section 121(d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those State standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for a invoking a waiver.

Alternatives 4, 5, 5A, and 6 all include a cap, although alternative 5 uses the compacted soil cap rather than the FML liner. Stringent testing would be necessary to show that a soil cap could meet the cover permeability requirement under the ARARs for closure of solid waste landfills; at present there is some doubt as to the certainty of achieving the required permeability. For comparison purposes, however, Alternative 5 will be considered further in the analysis.

Alternatives 4, 5, 5A, and 6 are expected to meet their respective ARARs, although the length of time necessary to meet Site groundwater RGs could be 30 years or more. The main ARARs for the different alternatives are discussed in Section I-2.

Additionally, while Alternative 4 is retained for consideration, it should be noted that both the EPA framework for MNA, and the corresponding State framework under "Mixing Zones" permits, do not typically allow ongoing surface water discharge such that surface water bodies are impacted above ambient water quality standards.

J.2 Primary Balancing Criteria

J.2.1 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

The main capping comparison concerns the inclusion or absence of a synthetic (FML) liner. Either type of cap, if properly maintained, can maintain permanent protection from the soil exposure pathway. While a compacted native soil cap is likely equally effective in isolating the wastes, it is greatly less effective at lessening the ongoing leaching of contamination to groundwater. The reduction of infiltration expected from the FML cap makes it superior to the soil cap in terms of long-term effectiveness.

The alternatives which use pump-and-treat methods, Alternatives 5 and 5A, would generally be expected to achieve long-term effectiveness and permanence. However, there could be problems in long-term performance and success, based on EPA and industry experience at many groundwater pump-and-treat sites. Chemical constraints are often present that lead to decreasing effectiveness over time. Monitored Natural Attenuation (Alternative 4) and Enhanced Biodegradation (Alternative 6) both rely on biological degradation of the contaminants, and the reduced contaminant levels both achieve should be permanent and thus long-term effective, once accomplished. However, Alternative 6 has an advantage in that the use of one or more amendments to enhance biological degradation offers the possibility of faster reduction in contaminant levels, as compared to MNA, which is limited to the ongoing, natural baseline rate of biological degradation. The MNA approach also has no means no prevent the continued discharge of groundwater to surface water. For these reasons, and in view of the potential for effectiveness problems with groundwater pump-and-treat systems, Alternative 6 has a clear advantage on this criterion.

J.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated *performance of the treatment technologies that may be included as part of a remedy.*

Alternatives 3, 4, 5A, and 6 include capping with the FML liner, the Presumptive Remedy, which is a containment action. However, the cap will accomplish a significant reduction in the mobility of the VOC waste that is leaching contamination into groundwater from within the landfill. Volume and toxicity of the waste will not be reduced; however, the volume of contaminated groundwater emanating from the landfill will be significantly reduced. The native soil cap included in Alternative 5 will achieve significantly less effect in this regard.

Alternatives 5 and 5A, which use groundwater recovery and treatment (pump-and-treat), will intercept and thus greatly reduce the mobility of the affected groundwater, through hydraulic capture, but lowering toxicity and volume will require that large amounts of groundwater be treated over long periods of time. Pump-and-treat systems also generate large amounts of treated groundwater that must be disposed of.

Alternative 4, using MNA, and Alternative 6, using enhanced biodegradation, both take advantage of biological degradation to reduce the toxicity and volume of contaminated groundwater, although degradation process can be slow and there is no change in groundwater mobility. With Alternative 6, however, the insitu biological treatments will enhance or *accelerate the biological processes, which affords the possibility of achieving the Site RGs faster* than would be possible with MNA.

J.2.3 Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup goals are achieved.

The most immediate potential for exposure at the Site, from Site soils, would be alleviated within 12-15 months upon completion of the cap. This applies equally to all remaining alternatives (4, 5, 5A, 6). About the same length of time is required whether or not the cap includes an FML liner.

Any potential short-term health and safety impacts likely to result from Site cleanup originate with the capping actions which are part of all remaining alternatives. Capping operations will involve extensive earth-moving operations, large areas of soil exposed for varying lengths of time, vehicular traffic, and related difficulties. These issues can be safely handled through proper application of occupational health and safety protocols, airborne dust suppression, control of surface water runoff, and similar measures. Coordination and outreach to nearby residents will be essential for minimizing impacts to residents (dust, noise). Short-term groundwater issues associated with the cap are not expected to be significant, and can be addressed through adherence to an approved site health and safety plan.

For groundwater, all of the alternatives involve long time periods to accomplish and verify the cleanup. Thus there is almost no difference in short-term effectiveness due to the relatively long period of time necessary to achieve RGs.

J.2.4 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Alternatives 5 and 5A, which use groundwater recovery and treatment, are implementable and should pose no particular difficulties beyond those expected for any engineering "construction" remedy where a treatment system, enclosure, building, and/or other structures must be built. Such actions typically have a multi-phase remedial design to design the system and its components.

Both Alternatives 4 (Capping (FML) and MNA) and 6 (Enhanced Biodegradation) are also readily implementable. In the case of Alternative 4, MNA must be done according to a strict protocol that involves extensive meetings and communication, the installation of additional wells (the most among the alternatives) to establish plume flow directions and boundaries, and other difficulties. However, the MNA framework does not accord well administratively with State regulations concerning groundwater and surface water cleanup, which can further complicate implementation. The need for a Treatability Study, and its central role in deciding the manner of applying MNA, are also factors considered.

Alternative 6 (Enhanced Biodegradation) also includes a Treatability Study that is similarly crucial in determining how to apply the in-situ treatments. Actual field implementation may pose some modest difficulties and complications, given limited industry experience with bedrock treatments, but these can most likely be overcome.

Overall, there is no clear distinction on this criterion. The pump and treat alternatives, Alternatives 5 (Capping (Soil) and Groundwater Pump & Treat) and 5A (Capping (FML) and Groundwater Pump & Treat) are more "off the shelf" and routine to implement, and thus easier to implement, although they do represent multi-phase large-scale engineering projects. The remaining Alternatives, 4 (Capping (FML) and MNA) and 6 (Capping (FML) and Enhanced Biodegradation) are readily implementable from a field/technical perspective, but both involve Treatability Studies and some administrative difficulties.

J.2.5 Cost

The final balancing criteria considered is cost. By comparing what each alternative is expected to accomplish, and its cost, to the other alternatives, the cost-effectiveness offered by each alternative can be considered.

As shown in Table I-2, Alternatives 5 and 5A have the highest costs. In terms of cost-effectiveness, EPA believes that no additional effectiveness is obtained for the $1.2- to $1.7-million cost differential between the two pump-and-treat alternatives, and the cost range of Alternatives 4 (Capping (FML) and MNA) and 6 (Capping (FML) and Enhanced Biodegradation). As noted above there could also be long-term effectiveness issues. For similar cost, Alternative 6 (Capping (FML) and Enhanced Biodegradation) offers the potential to achieve essentially the same cleanup, possibly in less time.

J.3 Modifying Criteria

J.3.1 State/Support Agency Acceptance

SCDHEC has reviewed the Selected Remedy and concurs with EPA's Preferred Alternative. South Carolina's letter of concurrence on this Record of Decision is attached at Appendix C.

J.3.2 Community Acceptance

At the public meeting held during the public comment period, community members had a number of general questions concerning the RI and the timing and scope of the proposed remedy. No specific preferences for any particular alternative were expressed. Two (2) sets of written comments were received, and one of those included specific concerns about the proposed remedy, although not disagreement with its selection (Appendix A). One citizen had a health-related question about RI findings. In general, the community is supportive of the selected remedy and is ready to see cleanup actions proceed as soon as possible.

K, PRINCIPAL THREAT WASTES

The NCP establishes an expectation that EPA will use treatment to address principal threats posed by a site wherever practicable. The 'principal threat' concept is applied to the characterization of 'source materials' at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water or air, or acts as a source for direct exposure. Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are defined as those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal threat wastes are those source materials that generally can be reliably contained and that would present only low risk in the event of exposure.

According to *A Guide to Principal Threat and Low Level Threat Wastes (OSWER 9380.3-06FS, November 1991)*, wastes that generally do not constitute principal threats include, but are not limited to, the following: (1) non-mobile contaminated source material of low to moderate toxicity (surface soil containing chemicals of concern (COCs) that generally are relatively immobile in air or groundwater, i.e., non-liquid, low-volatility, low-teachability contaminants such as high molecular weight compounds) and (2) low toxicity source material (soil and subsurface soil concentrations not greatly above reference dose levels or that present an excess cancer risk near the acceptable risk range were exposure to occur).

At this site, a determination of whether principal threat wastes exist in the landfill cannot be made, since minimal information is available on the physical and chemical characteristics of the waste. During the RI, extensive soil sampling and examination of landfill contents in test pits did not identify any "hot spots" or concentrated wastes. Samples from the other contaminated media (primarily groundwater) do not display the high concentrations and high toxicity levels that are characteristics of principal threat wastes.

L. THE SELECTED REMEDY

Based upon consideration of the requirements of CERCLA, the detailed analysis of the alternatives proposed in the feasibility study using the nine (9) criteria, and public comments, EPA
has chosen Alternative 6, FML Cap, Institutional Controls and Enhanced Biodegradation as the Selected Remedy for this Site.

The following sections provide the rationale and basis for selecting Alternative 6, an expanded remedy description, a summary of the expected costs, and a description of the expected outcome of implementing the remedy.

L.1 Rationale for the Selected Remedy

As discussed in the comparative analysis (Section J), capping of the Site using an FML liner, rather than compacted soil, achieves superior long-term effectiveness and significantly lowers the mobility of contamination leaching to groundwater, in addition to physically isolating the wastes and blocking exposure to Site soils. Among the groundwater components, the use of enhanced biodegradation achieves remediation of the groundwater COCs at the same or only slightly greater cost than Monitored Natural Attenuation (MNA). Because biological degradation processes are enhanced or accelerated, Alternative 6 also has the potential to accomplish treatment in less time than MNA. Alternative 6 accomplishes the treatment of impacted groundwater insitu, without the high capital costs and very-high O&M costs associated with groundwater pump-and-treat technology (Alternatives 5, 5A). This comparison holds even if repeat treatments of the biodegradation agent proved necessary. Alternative 6 is also superior to Alternatives 5 and 5A in view of concerns about long-term effectiveness of groundwater pump-and-treat technology.

L.2 Description of the Remedy

A general description of the Selected Remedy is presented in this section. The details of the remedial action, other than those given below, will be set forth and approved by EPA in the Final Remedial Design during the Remedial Design/Remedial Action (RD/RA) phases of the Site response.

The major components of the Selected Remedy (Alternative 6) are:

- Construction and installation of an FML cap
- Implementation of enhanced biodegradation processes for groundwater
- Institutional controls to limit Site use
- Monitoring of groundwater

The Presumptive Remedy component consists of the construction of an FML cap in accordance with the ARARs for solid waste landfills, and the long-term O&M of the cap. To construct the cap, waste will be moved and consolidated as necessary to bring the contents to within the boundaries shown on Figure I-1. The final footprint of the capped enclosure will be determined in the Remedial Design. The entire landfill contents will be covered with soil, in lifts, in thicknesses required by the relevant and appropriate State and Federal ARARs. The soil lifts will be compacted to the permeability required by the ARARs (generally, a criterion of 1×10^{-5} cm/sec unless otherwise approved in the Remedial Design). An FML will be installed over the compacted soil. The FML will be covered with soil layers constructed in accordance with the ARARs, and a vegetative cover (root zone) will be established on the cover. Unless determined otherwise during the design, the remedy will include moving and consolidating wastes as needed to allow a 100-foot cleared, unoccupied road corridor to remain onsite, as shown in the FS. The potential road corridor will not be capped. Fencing around the Site perimeter may be employed, if confirmed in the Remedial Design to be necessary for construction security. Additional requirements will be specified in the Remedial Design.

The groundwater component of the Selected Remedy consists of using Enhanced Biodegradation. This term refers to a group of related methodologies that enhance microbial degradation of chlorinated organics by providing, to the indigenous microbial populations, a substrate that furthers their degradation of the organic compounds. There are a number of process options, relating to the particular substrate used, and because of their similarities, one or more of them could be used. Known process options include injection of molasses, and injection of vegetable oil. Others which may be suitable for use will be identified in the Treatability Study (see below).

A pilot-scale Treatability Study will be conducted during the Remedial Design. At a minimum, the purposes of the Treatability Study will include: a) identification and comparison of possible delivery strategies and methodologies for addressing delivery into the fractured bedrock system; b) identification and comparison of possible treatment solutions/reagents; c) and gathering of other appropriate design information. The Treatability Study may be initiated before cap construction and installation is complete; however, the pilot-scale testing that is expected to be a crucial component cannot be performed until the effects of the cap on underlying groundwater are known, so that the evaluation is focused on the groundwater conditions that exist under the cap at that time and afterwards.

Unless a different strategy is approved in the Remedial Design, the treatment will be targeted on those areas around the northeast toe, and southeast toe, of the landfill that were found in the RI to be significant sources of contaminants to the groundwater (Figure I-4). However, Treatability study results will be considered in selecting the actual locations where the treatment is to be performed.

An example of this group of technologies is Hydrogen Release Compound, or HRC. HRC is a proprietary, environmentally safe polylactate ester, such as sorbitol polylactate ester, which has been formulated for the slow release of lactic acid and a low-level supply of hydrogen upon contact with water. Lactic acid occurs naturally in milk and foods. HRC enhances natural attenuation in two ways. First, HRC provides a substrate for microbes to assimilate oxygen (to promote anaerobic conditions within the aquifer) or to assimilate nitrate and sulfate, which compete with chlorinated volatile organic compounds such as PCE in anaerobic biological reactions. Secondly, HRC provides a hydrogen source, or electron donor, which can be used by microbes which participate in reductive de-chlorination of chlorinated VOCs, or electron acceptors. One feature of HRC in contrast to other substrates that use other electron donors, such as sugar and molasses, is that it is designed to release hydrogen over a longer time period, requiring less frequent re-application.

In general, the process that will be used consists of injection into the subsurface, in the areas downgradient of the landfill where the concentrations of chlorinated VOCs are highest. Using HRC as an example, HRC is prepared into a gel form that would be injected using a direct hydraulic push technology, such as GeoProbe®. A column of HRC would be injected from probe refusal, which is presumably the top of bedrock, to the top of the water table. For bedrock, the material will be injected into bedrock fractures by pumping into wells, although the specifics of this will be based upon the results of the Treatability Study.

EPA and SCDHEC expect that, with refinement of the treatment process during pilot testing, enhanced biodegradation will be effective in reducing COC levels in Site and offsite-migrating groundwater. As noted, RI data show that the microbial breakdown products of PCE are widespread in Site groundwater; the planned treatments enhance this ongoing degradation and thus accelerates the destruction of the COCs.

It is possible that the enhanced biodegradation treatment may require re-applications, depending on the effectiveness demonstrated in testing. In the event that three (3) treatments do not prove effective, EPA and SCDHEC will review the remedy's effectiveness and will consider modifying or changing the Site Selected Remedy in accordance with the NCP and EPA guidance (e.g. an Explanation of Significant Differences or ROD Amendment, as appropriate).

The Selected Remedy employs Institutional Controls to supplement the active remedial measures by preventing exposure to contaminants in the surface and subsurface soils and underlying landfill materials, and preventing consumption of groundwater beneath the Site and nearby affected adjoining properties during the period of active treatment. Land use decisions by the local community and authorities are likely to take some time to work out, as the ongoing "Regenesis Project" proceeds, making it inappropriate to specify, at present, which controls are best for the situation. An Institutional Controls Plan will be required (and approved by EPA) as part of the Remedial Design, to specify the controls needed for both the Site property and nearby affected adjoining properties.

Institutional controls will be necessary for the Site, since physical access to the Site is unrestricted, and since the cap will require more than one year to install. The purpose of any controls used for the Site property, which could include easements or covenants, or possibly deed notices, will be to prevent exposure to Site soils. Similarly, institutional controls may also be necessary on adjoining properties underlain by offsite-migrating COCs. To the southeast, Site contaminants are present in the area of MW-9; to the northeast, contaminated Site groundwater appears to be migrating offsite under the former IMC Fertilizer plant property and discharging to the creek. Control measures would be intended only to restrict the use of groundwater. The IMC Site has an ongoing RI/FS in progress, and the need for any controls in the near term is unlikely. The "Institutional Controls Plan" noted above will address offsite properties as necessary. EPA expects to work with the landowner, local authorities, and the community to ensure that Site use remains consistent with the remedy.

Finally, groundwater monitoring for Site COCs (Table H-1) will be performed during the entire duration of the Remedial Design and Remedial Action phases. The wells shown in Figure I-2 will be used, along with other wells that may be installed during these phases of work. A semiannual (twice annually) sampling schedule will be maintained initially, unless a different scheme is approved by EPA during design.

L.3 Summary of the Estimated Remedy Costs

Appendix D provides a detailed breakdown of the anticipated remedy costs. The capital costs are \$4,565,000 for the cap and \$288,000 for groundwater. Present worth cost for 30 years of annual O&M total \$675,000 for cap maintenance and \$516,000 for groundwater O&M. The grand total for the Selected Remedy is \$6.05 million. Although the costs shown appear detailed, it should be noted that they were prepared without benefit of detailed, remedial design and engineering information and (in accordance with guidance) are only expected to be accurate to within +50 to -30 percent of the eventual, actual project cost.

L.4 Expected Outcome of the Selected Remedy

The Selected Remedy will, upon completion of cap construction, leave the property usable for the types of recreational use described generally in Section F. The cap isolates the wastes and blocks both current and future exposure pathways (dermal contact, ingestion inhalation) for Site visitors. The land usage foreseen is limited only to the degree that it must not interfere with proper maintenance of cap integrity. This would preclude any uses that include construction of buildings. Maintenance of the cap is required to maintain the risk reduction. Cap construction (including design) will require an estimated 12 to 15 months.

Groundwater use on the Site and the adjoining (north, southeast) properties will be impaired during the time period over which the groundwater remedy component is implemented. The length of time required is very difficult to predict, and could be more than 30 years. Upon attainment of the Site RGs (Table H-1), the groundwater beyond the treatment points (beyond the cap edge) will be returned to potential beneficial use as a potable water source.

Implementing the Selected Remedy is expected to provide a boost to ongoing community revitalization efforts, by addressing environmental and health-risk concerns about the Site, and through making the Site available for uses that accord well with the community's vision for their area. Environmental benefits may also be gained to the degree that recreational use of the Site, particularly if it includes a planned "Greenway" along Fairforest Creek, brings additional local attention to the areas of trash and debris present along both sides of the creek north and south of the Site. These areas are scheduled to be surveyed and investigated under the area-wide Brownfields project currently in progress.

M. STATUTORY DETERMINATIONS

Under CERCLA §121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (ARARs) (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against offsite disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

M.1 Protection of Human Health and the Environment

The Selected Remedy, Alternative 6, provides adequate protection of human health and the environment by implementing the remedy components: design and installation of a Flexible Membrane Liner (FML) cap, design and implementation of enhanced biological degradation treatments, using appropriate institutional controls, and conducting groundwater monitoring.

Capping will eliminate the potential for exposure to Site soils and landfill wastes. The cap will reduce the current levels of carcinogenic risk through soil exposure (1.57×10^{-6}) to below 1×10^{-6}. Additionally, the cap achieves a measure of source control by minimizing leaching of Site COCs to groundwater.

Groundwater treatment using enhanced biodegradation will reduce or eliminate concentrations of Site COCs above the RGs, and is expected to achieve the Site RGs. Remaining carcinogenic and noncarcinogenic risks will be below those shown in Table H-1.

The implementation of the Selected Remedy will not pose unacceptable or unreasonable short-term risks, or significant cross-media impacts. The potential exposures which drive the most immediate human health risks at the Site are addressed in the short term by capping. Potential exposure under the future use scenario, through groundwater use, will be addressed over the expected longer period of groundwater remediation.

M.2 Compliance with ARARs

The Selected Remedy, Alternative 6, complies with ARARs. The ARARs that will govern the Selected Remedy are discussed below.

Action-specific ARARs that govern the capping activities are the RCRA Subtitle D landfill requirements (40 CFR Part 258), and the State of South Carolina Solid Waste Management Regulations for municipal landfills (Reg. 61-107.258), which are judged relevant and appropriate. Federal Occupational Health and Safety Administration (OSHA) regulations regarding work on hazardous waste sites (29 CFR Part 1910.120) are applicable to the onsite work during cap construction.

Certain chemical-specific ARARs are relevant and appropriate to capping. Since the landfill has soil erosion and surface water runoff going into Fairforest Creek, the action plays a part in complying with the Federal and State Ambient Water Quality Criteria (AWQC) regulations established under the Clean Water Act (40 CFR Part 131, SC Reg. 61-69). For the same reasons, the storm water provisions of the National Pollutant Discharge Elimination System (NPDES) are applicable to cap construction. Regarding landfill gas, for which a passive venting system is included in the Selected Remedy, Clean Air Act requirements are not foreseen for the passive venting planned under the capping alternatives, based on Site data. If emissions are later determined to require treatment, Federal and State regulations (e.g. SC Air Pollution Control Regulations, Reg. 61-61) that implement the Clean Air Act (40 USC § 1857) would become relevant and appropriate for use.

Three location-specific ARARs are applicable to capping because the capping action will involve land along Fairforest Creek, some of it wetlands, and since the action could alter or affect the creek itself. These three are:

- Executive Order 11988 (Floodplain Management; 40 CFR Section 6, Appendix A)
- Fish and Wildlife Coordination Act (40 CFR Section 6, Part 302)
- Wetlands Protection Act (Executive Order 11990 and Clean Water Act Section 404)

Chemical-specific ARARs relevant and appropriate to the groundwater remedy component are the State and Federal regulations established pursuant to the Safe Drinking Water Act. The National Primary Drinking Water Standards (40 CFR Part 141) established the MCLs for constituents in drinking water to include groundwater aquifers used as potable water sources. The corresponding South Carolina regulation is SC Reg. 61-58. These regulations sets MCLs for six (6) of the 24 COCs in groundwater at the Site: tetrachloroethene (PCE), trichloroethene (TCE), 1,1-Dichloroethene, cis-1,2-Dichloroethene, benzene, and vinyl chloride. MCLs are specifically identified in the NCP as remedial action objectives for groundwater that is a current or potential source of drinking water (NCP 40 CFR § 300.430(a)(1)(ii)(F).

Two action-specific ARARs are applicable to the groundwater action. The Federal Occupational Health and Safety Administration (OSHA) regulations concerning work on hazardous waste sites (29 CFR Part 1910.120) are applicable to onsite work during activities such as groundwater sampling, surface water sampling, construction of wellpoints for injections, performing the injection treatments, or others. Finally, the South Carolina regulation for monitor well installations procedures and standards, SC Reg. 61-71, is applicable to all wells used in the Selected Remedy.

M.3 Other Criteria, Advisories, or Guidance To-Be-Considered (TBCs)

In implementing the Selected Remedy, USEPA may choose to follow criteria, advisories or guidance which would be non-binding. No TBCs were identified in the FS.

M.4. Cost-Effectiveness

In EPA's judgement, the Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (40 CFR 300.430(f)(1)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (Alternatives 4, 5, 5A, and 6). Overall effectiveness was evaluated by assessing three (3) of the five (5) balancing criteria in combination: long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness. Overall effectiveness was then compared to costs to determine cost-effectiveness, for each alternative, and for the alternatives in comparison to one another. The overall effectiveness of this remedial alternative was judged to be proportional to its costs, and therefore it represents a reasonable value for the money to be spent.

Among the remedial alternatives which meet the threshold criteria (Alternatives 4, 5, 5A, and 6), Alternative 6 achieves biological degradation of the groundwater COCs at the same or only slighly greater cost than Monitored Natural Attenuation (MNA, Alternative 4). Significantly, it has the potential to accomplish treatment in less time than MNA. Alternative 6 accomplishes the treatment of impacted groundwater insitu, at much lower capital costs and long-term O&M costs than Alternatives 5 and 5A, which use groundwater pump-and-treat technology. This comparison holds even if repeat treatments proved necessary. For these reasons, Alternative 6 is the most cost-effective of the available choices.

M.5 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

EPA has determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Site. Among the remedial alternatives which meet the threshold criteria (Alternatives 4, 5, 5A, and 6), EPA has determined that the Selected Remedy provides the best balance of trade-offs in terms of the five primary balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against off-Site treatment and disposal, and considering State and community acceptance.

The Presumptive Remedy, capping, is a long-term containment action which isolates the source materials at the Site (within the landfill) and provides some degree of source control against groundwater leaching. Under the Presumptive Remedy approach, neither source removal nor source treatment is practicable.

The groundwater component uses implementation of enhanced biological degradation treatments, an innovative and emerging treatment technology, to treat contaminated groundwater insitu, and permanently destroys or degrades the contaminants through biological action. This represents a permanent treatment that best satisfies the criteria for long-term effectiveness in comparison with other alternatives which use pump-and-treat technology, which often have problems regarding long-term performance.

Institutional controls will be used as needed to control land and groundwater uses during the period of active treatment at the Site.

M.6 Preference for Treatment as a Principal Element

As described above, direct treatment or removal of the source materials (principal threat wastes) in the landfill which are leaching to groundwater, is not feasible. Therefore, under the Presumptive Remedy, the preference for treatment of principal threat wastes as a main remedy component, cannot reasonably be met.

The groundwater component of the Selected Remedy achieves in some degree the intent of the preference for treatment. The enhanced biodegradation treatments do not generate additional waste materials that could require disposal, or transfer the contaminants to those media (spent carbon, vapor emissions) as would have been the case had Alternative 5 or 5A (which use groundwater pump-and-treat) been selected.

M.7 Five-Year Review Requirements

Section 121(c) of CERCLA, as amended, and the NCP provide the statutory and legal bases for conducting five-year reviews. If there are any hazardous substances, pollutants, or contaminants remaining at the Site above levels that would allow unlimited use and unrestricted exposure, EPA must conduct a review of such remedial action no less often than each five (5) years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In general, a five-year review covers all operable units at a Site.

The Five-Year Review requirements at the Arkwright Dump Site are controlled by the Presumptive Remedy for the Site, capping. EPA 5-Year Review Guidance states that a statutory Five-Year Review will be conducted at any CERCLA site at which remedy completion will not allow unlimited use and unrestricted exposure. A landfill is an example of such a site. Completion of the capping remedy component will eliminate risks from soils and landfill materials, but will not allow unrestricted use; use of the Site will always be restricted to the degree necessary to maintain the cap and assure its effectiveness and integrity. Therefore, a statutory Five-Year Review will be conducted at the Site every five years, in perpetuity, in accordance with the NCP.

N. DOCUMENTATION OF SIGNIFICANT CHANGES

Four changes are reflected in this Record of Decision that differ slightly from the information presented to the public in the Proposed Plan.

The first concerns the costs shown in this ROD for Alternative 6, which was selected as the remedy. After the FS was approved, it was discovered that the groundwater monitoring analytical costs (item 7.10, costs for Alternative 6, in Appendix C of the FS) should have included 40 VOC samples rather than 34, to allow for six samples representing the two "impacted surface water segments" referred to in the Proposed Plan. This additional cost adds $1800 to the annual O&M cost and $22,000 to the overall remedy total; however the same amount would have been added to any of the four alternatives (4, 5, 5A, 6) that included a groundwater component, if selected. Therefore it has no significance in the comparisons made in the comparative analysis (Section J).

Under the Remedial Objectives for the Site, it was implied (RAO No. 2 under "Groundwater") by the language that groundwater under the cap would be restored to potential use as a potable water source. The RAO on page 38 of this ROD, to be used in the Selected Remedy, clarifies that restoration of the aquifer is the RAO for all contaminated groundwater that is not under the cap, once constructed.

Third, the non-carcinogenic and carcinogenic risk totals presented in the Proposed Plan are slightly different from those presented here, which are based on the finalized, approved Baseline Risk Assessment. The changes do not affect the characterization of Site risks as presented to the public, nor do they affect the risk basis for requiring action at the Site. These differences are summarized below.

Risk Element	Proposed Plan, July 2002	Record of Decision
Carcinogenic Risk - Current Site Visitor (child age 7-12) (Lifetime)	1.5×10^{-5}	1.57×10^{-5}
Carcinogenic Risk - Future Site Visitor (child age 7-12) (Lifetime)	1.5×10^{-5}	1.57×10^{-5}
Noncarcinogenic Risk - Future Offsite Resident: Child age 1-6 Child (age 7-12) Adult	 201 111 78	 360 222 142
Carcinogenic Risk - Future Offsite Resident - Adult (Lifetime)	1.2×10^{-2}	7.25×10^{-3}

Finally, in the Proposed Plan, the RG for manganese (880 μg/L) was shown to be based on the Region 9 PRG, and the RG for naphthalene (25 μg/L) was shown as based on the South Carolina risk-based standard for UST releases. Calculations in the Final of the Baseline Risk Assessment provide a better Site-specific RG in both cases, and those are the values shown in Table H-1, Remedial Goals.

APPENDIX A
RESPONSIVENESS SUMMARY

RESPONSIVENESS SUMMARY
RECORD OF DECISION, ARKWRIGHT DUMP SITE, SPARTANBURG SC
September 2002

Introduction

The Responsiveness Summary is required by the Superfund law (CERCLA) and the NCP, to provide a summary of citizen comments and concerns about the Site, as raised during the Public Comment Period, and a description of the Agency's responses to those concerns (CERCLA §117 and NCP §§300.430(f)(3)(i)(F) and 300.430(f)(5)(iii)(B)). All comments summarized in this document have been considered in the development of the Selected Remedy for the Arkwright Dump Site.

The following issues and concerns were expressed during the public comment period by the local community, and by a contractor for the RI/FS project at the adjoining former IMC Fertilizer plant site. The comments are transcribed here in their entirety. Although not included here, the actual comment letters received during the public comment period, and a transcript of the public meeting, are a part of the Administrative Record for this Site.

PART 1: Local Community Comments and EPA Responses:

Comment No. 1: Community Baptist Church has its eyes on building a new Church. We are located directly across from the dump (the host site for this meeting) in Arkwright. Is the contamination of the soil and gas emissions both ground and airborne such that we should not rebuild in the same location? If the soil on which the Church is located has been tested what were the results?

RESPONSE: The results from the soil and soil vapor samples collected at the church are not significant in terms of any potential health risks. There is no reason, in EPA's judgement, why the church could not re-build on the same location.

Results from soil and soil vapor samples are shown in Tables 2.3, 2.4, 2.5, 2.6, and 2.18 of the Feasibility Study (samples labeled "SS-BKG" and "SVP-BKG"). In surface soil, five organic compounds were detected. All of the levels detected are far below any health-based risk benchmarks. Three of the five are gasoline components and probably relate to accidental spillage of gasoline. Deeper soil (40-42 feet below the ground) was sampled and had four organic compounds present; these also were all far below any levels that would cause concern.

The soil vapor sample was collected from a vapor well screened from 30 to 40 feet below ground surface. Six organic compounds were detected. The levels of four of these are above those recommended for ambient air; however, they were detected in a vapor sample from 30-40 feet below ground. The sample does not mean that vapor containing these levels is coming up and entering the air near the church; but even if this is the case, it is highly unlikely that it would pose a problem for siting a new church. Modern construction methods include vapor barriers, which would prevent problems from vapors. If the landfill is the source of the compounds detected, the passive landfill gas venting system that is part of the Selected Remedy (the cleanup plan), and the effect of the cap itself, should greatly reduce the amount of landfill gas (including vapors) escaping from the Site.

Part II: Technical Comments from Contractor on the Former IMC Fertilizer Site

The first five (5) comments concerned the Feasibility Study Report and the Proposed Plan.

Comment No. 1: One of the four Remedial Action Objectives identified in the Feasibility Study Report (Executive Summary, page ES-1 and Section 3, page 3-1) for the Arkwright Dump Site is to "reduce or eliminate the migration of groundwater off site containing contaminants over regulatory levels." The array of alternatives is limited in that only two active remediation technologies: HRC injection for enhanced bioremediation, and migration control using groundwater recovery and treatment, are carried forward as viable technologies to address migration control. A number of technologies are discarded in the screening phase (Section 4) due to limited effectiveness of potential implementation concerns under fractured bedrock conditions. In point of fact, the challenging geologic conditions are also likely to equally impact the effectiveness/implementation of the two retained technologies. There thus appears to be no consistent basis for discarding alternative treatment technologies in the screening phase.

RESPONSE: EPA would like to clarify the bases for screening out certain treatment technologies, which may have been misunderstood.

In situ treatment of a source area, and techniques that might use physical barriers such as Permeable Reactive Barriers (PRBs) or reactive walls, were not retained because the locations of sources inside the landfill are not known, and because the depth of contamination will likely interfere with proper installation of such barriers. Several anaerobic treatment options were retained even though implementation may be challenging or difficult. Other anaerobic processes that involve injection of a pollutant, such as methanol or nitrate, or hazardous material, such as methane or propane, were eliminated, for environmental and health/safety reasons. Finally, aerobic biodegradation processes were eliminated because they were not deemed effective on tetrachloroethene or trichloroethene.

Comment No. 2: Compliance with South Carolina Solid Waste Regulations for Municipal Landfills (R.61-107.258) is presented in the Feasibility Study Report (Table 3.2) as "Relevant and Appropriate," but not "Applicable."

The basic design components for final cover and landfill gas control appear to generally meet state requirements. Two types of liner systems are evaluated: a soil cover, and a flexible membrane liner (FML). Based on HELP model calculations in the Feasibility Study Report, there is a marked difference in the predicted amount of infiltration that will occur between these two systems (soil cover produces > 14 million gallons of leachate per year; FML at 10^{-9} cm/sec permeability produces < 200,000 gallons of leachate per year). Most of the developed alternatives incorporate use of the FML capping system. However, the Feasibility Study Report leaves open the type of liner to be selected in the final design. The HELP model presented in the Feasibility Study Report relies upon a very low permeability value (10^{-9} cm/sec) which is applicable to a geo-composite liner. The final design should be critically reviewed to confirm that the criteria serving as the basis for remedy selection is maintained in the design. Of the four liner types presented, there are concerns with the long-term durability of liner low density polyethylene (LLDPE) or very low density polyethelene (VLDPE) materials, especially if a traffic road is going to be constructed.

RESPONSE: As the comment recommends, the remedial design (RD) will be critically reviewed, as it develops and is evaluated by EPA and SCDHEC, to confirm that the criteria serving as the basis for remedy selection is maintained in the design. In the Feasibility Study (FS), the HELP model was based on a permeability value of 10^{-9} cm/sec, which is the typical permeability of a geosynthetic clay liner, one of the FML options cited in the report. Because the plastic sheeting has essentially no permeability, the permeability of the geosynthetic liner was chosen in order to be conservative.

The FS incorporated a capping alternative that included a corridor for a possible future road. The location of the corridor was selected because the volume of waste is minimal along that path. The Feasibility Study assumed that all of the waste would be removed from that area; therefore, the FML cap would not be installed over any areas containing waste.

Several flexible membrane liner (FML) materials were listed in the Feasibility Study. Linear Low Density Polyethylene and Very Low Density Polyethylene were included with others in order to give the designer flexibility in selecting the appropriate FML material, while maintaining the intended permeability standard.

Comment No. 3: A 3 (horizontal) to 1 (vertical) side-slope is proposed along the landfill margins in the eastern portion of the Arkwright Dump Site. This is generally "acceptable maximum" design value and appears to be used in the Arkwright Feasibility Study Report design primarily based on existing waste distribution. However, use of this design value in remedy implementation raises the following issues:

3(a). The areas that exhibit a 3:1 slope along the northern and eastern boundaries are immediately adjacent to surface water streams. This could present a concern as the structural integrity of these areas could be compromised under high storm flow conditions in the streams. The steep slope along the northern property line may also cause water to rise to a greater elevation on adjacent properties under storm flow conditions.

RESPONSE: The FS capping alternatives brought forward (and the cap option included within Alternative 6, the Selected Remedy) includes moving approximately 50,000 cubic yards of landfill materials in order to develop a 20-foot buffer zone between the edge of the cap and the property lines, and to achieve 3:1 slopes. Maps (see Figs. 2.1 and 4.2, FS) indicate more than 40-50 feet between the property line and the tributary on the north Site boundary, and that the waste-edge limit is no closer than approximately 50 feet to Fairforest Creek. These distances, plus the 20-foot buffer zone, should prevent the landfill from being the cause of any damage during periods of high flow in the streams. During the development of the RD, EPA will ensure that the requirements for erosion control and runoff control include robust and appropriate measures on the capped waste areas along stream boundaries.

3(b). Since minimal waste consolidation is included in the proposed alternative, there may not be sufficient space available to implement storm water diversion structures along the toe of the newly capped landfill. It appears that storm water would sheet-flow directly from the landfill surface into the adjacent streams, potentially exacerbating the influence of a high storm flow from the landfill to adjacent properties.

RESPONSE: EPA believes the waste consolidation contemplated in the action is considerably more that minimal; as noted, approximately 50,000 cubic yards of landfill materials, and 12,000 cubic yards in the "burn mound"area (northeast corner), will be moved and consolidated. The response above, concerning distances and erosion controls, addresses this comment as well. The measures should be effective in minimizing any storm/high-flow problems. We agree that the need for functional erosion and runoff controls is highly important, and we will ensure that the RD is successful in this regard.

3(c). A road placed onto the landfill cap, developed as a design option for the cap, could increase the storm flow into the streams and further exacerbate erosion issues along the sloped Dump Site boundaries. The FS (Section 4.5) notes "community support" for this structure.

RESPONSE: Assuming the potential road corridor is retained in the RD, there will be no waste remaining in the corridor area, since it will have been moved. Vegetation and diversion ditches would be used to manage the storm water in the corridor. If a road is designed and constructed across the corridor, the storm water generated by that road will have to be addressed during the design of that road, and this should present only minimal problems.

Comment No. 4: The extent of the cap (and potentially the waste also) appears to be depicted on conceptual drawings presented in the Feasibility Study Report as extending onto adjacent properties. Issues with slope stability and storm water management could be addressed if waste relocation and surface contouring would be incorporated into the cap design, to more evenly distribute the waste across the entire footprint of the waste area. The final contouring could then be designed to reduce the severe slopes in the eastern portion of the landfill. Minimally, to address these issues outlined in Comment #3 above, any remedy should pull back waste from the northern and eastern edges.

RESPONSE: The property lines in the FS figures are approximate; however, the comment is correct in the interpretation that the area underlain by wastes likely extends beyond the Site boundaries in some areas. The FS option brought forward and selected in the remedy presumes that the landfill materials will be consolidated on to the body of the landfill to develop a 20-foot buffer zone between the cap and the property boundaries, and between the cap edge and surface water. The slopes will be contoured to 3:1. The consolidation of waste will require moving approximately 50,000 cubic yards of landfill materials around the slopes and about 12,000 cubic yards from the "burn mound."

Comment No. 5: Hydrogen-Release Compound (HRC) treatment could be an appropriate technology for groundwater remediation of chlorinated VOCs. A high degree of natural breakdown of tetrachloroethene and trichloroethene to daughter products has already occurred and providing an electron acceptor to enhance the anaerobic biodegradation process would likely be successful.

We have the following concerns regarding the development of this alternative in the Feasibility Study Report and Proposed Plan:

5(a). The identified HRC treatment zone is not continuous, with a non-treated area in the east-central part of the landfill shown. This could be a remnant of monitoring well placement, and may need to be addressed in the remedy design.

RESPONSE: For comparison at the FS stage, Alternative 6 focused the groundwater treatment on the highest known concentrations of contaminants nearest the sources. Also taken into account was the lack of any surface water or groundwater detections (creek bed) in a long segment of Fairforest Creek, from just east of MW-2, down to the southeast property corner, and the relatively unimpacted well MW-3. The issue of where to effect the treatment will be addressed further in the Treatability Study.

5(b). The estimated number of injection points and the capital costs to implement an HRC program look low, by a factor of two or more based on recent pilot project experience and estimates for full-scale application in similar geology.

RESPONSE: The commenter's estimate could be correct; it is difficult to accurately estimate the necessary number of injection points and the costs. EPA will take this into consideration in the RD. However, the effectiveness, cost, and other comparisons made in the Record of Decision still hold overall, and are still correct.

5(c). The argument to delay HRC pilot implementation until after the landfill cap is placed is not strongly supported. The pilot would be expected to take 6 to 9 months and could be address these issues outlined in Comment #3 above, any remedy should pull back waste from the northern and eastern edges.

RESPONSE: The property lines in the FS figures are approximate; however, the comment is correct in the interpretation that the area underlain by wastes likely extends beyond the Site boundaries in some areas. The FS option brought forward and selected in the remedy presumes that the landfill materials will be consolidated on to the body of the landfill to develop a 20-foot buffer zone between the cap and the property boundaries, and between the cap edge and surface water. The slopes will be contoured to 3:1. The consolidation of waste will require moving approximately 50,000 cubic yards of landfill materials around the slopes and about 12,000 cubic yards from the "burn mound."

Comment No. 5: Hydrogen Release Compound (HRC) treatment could be an appropriate technology for groundwater remediation of chlorinated VOCs. A high degree of natural breakdown of tetrachloroethene and trichloroethene to daughter products has already occurred and providing an electron acceptor to enhance the anaerobic biodegradation process would likely be successful.

We have the following concerns regarding the development of this alternative in the Feasibility Study Report and Proposed Plan:

5(a). The identified HRC treatment zone is not continuous, with a non-treated area in the east-central part of the landfill shown. This could be a remnant of monitoring well placement, and may need to be addressed in the remedy design.

RESPONSE: For comparison at the FS stage, Alternative 6 focused the groundwater treatment on the highest known concentrations of contaminants nearest the sources. Also taken into account was the lack of any surface water or groundwater detections (creek bed) in a long segment of Fairforest Creek, from just east of MW-2, down to the southeast property corner, and the relatively unimpacted well MW-3. The issue of where to effect the treatment will be addressed further in the Treatability Study.

5(b). The estimated number of injection points and the capital costs to implement an HRC program look low, by a factor of two or more based on recent pilot project experience and estimates for full-scale application in similar geology.

RESPONSE: The commenter's estimate could be correct; it is difficult to accurately estimate the necessary number of injection points and the costs. EPA will take this into consideration in the RD. However, the effectiveness, cost, and other comparisons made in the Record of Decision still hold overall, and are still correct.

5(c). The argument to delay HRC pilot implementation until after the landfill cap is placed is not strongly supported. The pilot would be expected to take 6 to 9 months and could be completed during cap design. Construction of the cap itself would not be expected to alter the groundwater conditions in the short-term. Adding the cap may improve the HRC treatment by creating a more anaerobic aquifer environment although this would be expected to take years to occur.

RESPONSE: The Selected Remedy, as described in Section L of this Record of Decision, allows the Treatability Study to be initiated before cap construction is complete, but states that the Treatability Study must focus on the groundwater situation under the cap, once installed. The remedy maintains flexibility under which the Treatability Study can be planned, and proceed, as observations and decisions are made about the underlying groundwater. The effect of the cap itself, on infiltration and contaminant leaching, should not be discounted.

5(d). As currently outlined, the preferred remedy does not appear to address elevated concentrations of VOCs in the bedrock portion of the aquifer. HRC treatment could be extended into bedrock, although its success would be dependent on direct knowledge of the underlying fractured flow system.

RESPONSE: The Proposed Plan (page 3) notes deep contamination in well MW-4D; and EPA's Project Manager stated verbally at the public meeting that contamination was present in the deeper bedrock wells, and that the remedy must address that contamination. EPA believes this was understood by the public. The Treatability Study will include planning for treatment in the fractured bedrock.

Nine (9) comments concerned the Baseline Human Health Risk Assessment.

Comment No. 6: Table 2.1, Summary of Surface Soil Screening, indicates that manganese is not retained as a constituent of potential concern (COPC). The maximum detected concentration listed for manganese in Table 2.1 is greater than the adjusted (HQ=0.1) Region IX PRG for residential exposures. Likewise, manganese is named as a human health COPC in the narrative of Section 2.5.1. Table 2.7, Chemicals of Potential Concern (Human Health) does not list manganese as a human health COPC. Please clarify the status of manganese as a human health COPC.

RESPONSE: As commenter notes, Section 2.5.1 states that manganese exceeds the Region 9 PRG (1/10). It should also have explained, however, that manganese was not detected at greater than 2 times background, and in accordance with RI/FS guidance, is not Site-attributed. This error was uncorrected from an earlier version of the document. In this case and for several of the comments below, EPA was aware of this error but elected to approve the document nonetheless, because it is not judged significant in terms of decision-making for the Site remedy.

Comment No. 7: Table 2.1, Summary of Surface Soil Screening, indicates in footnotes that selenium is not included as a human health COPC in risk determinations but will be considered in any remedy selection. Selenium is included in the noncarcinogenic and carcinogenic calculations for exposures to soil as presented in Appendix C.

RESPONSE: Selenium should not have appeared in Appendix C. Its maximum detection was below 1/10 the PRG. However, comments from EPA had directed that it be retained for consideration because the maximum detection was above the Soil Screening Level for Dilution-Attenuation Factor = 1, indicating the potential to leach to groundwater.

Comment No. 8: There are inconsistencies in the exposure point concentration for the soil COPCs; DDT, DDE, and cadmium listed in Table 2.1 and the risk and hazard calculation tables presented in Appendix C.

RESPONSE: There were typographical errors in Table 2.1 involving those analytes. The values in Appendix C are correct.

Comment No. 9: The source of the sediment exposure point concentrations for arsenic and chromium in the risk and hazard calculation tables presented in Appendix C is not clear.

RESPONSE: The error was that the concentrations are in the wrong units, they should have been presented as milligrams.

Comment No. 10: The surface water COPCs presented in Table 2.7 are inconsistent with constituents presented in surface water risk and hazard calculation tables presented in Appendix C.

RESPONSE: EPA cannot confirm the possible error noted here. Three substances are named on Table 2.7 and all three appear in the appropriate table in Appendix C. PCE and manganese have noncarcinogenic effects, while PCE and dioxin have carcinogenic effects.

Comment No. 11: The groundwater COPCs presented in table 2.7 are inconsistent with constituents presented in the groundwater risk and hazard calculations tables presented in Appendix C.

RESPONSE: Chromium should have been retained in Table 2.7. The constituents in the tables in Appendix E are the correct ones that should have had calculations performed. EPA was aware of the error.

Comment No. 12: The USEPA has noted in associated site documentation that "Fairforest Creek is a fishery." A completed fish consumption exposure pathway is not included for current/future recreational receptors or the future residential receptors. Please provide the rationale for the absence of a quantitative evaluation of this potential pathway.

RESPONSE: During Site Assessment work, local or state officials are contacted to determine whether a surface water body is a fishery. Making preliminary Hazard Ranking System (HRS) determinations does not require that evidence of fishing or shellfish-harvesting be present on the site. At the RI/FS stage, however, a risk management decision is made about whether or not a fish- or shellfish-consumption scenario is appropriate for consideration in the Baseline Risk Assessment. No evidence of fishing was present on the property, and residents did not indicate that this was occurring. EPA did not, therefore, include this scenario in the assessment.

Comment No. 13: There are a number of statements in the discussion section that suggest off-site sources for some of the chemicals screened (e.g. the discussion of dioxin and metals in sediment). These discussions do not take into account (a) potential wind dispersion of dioxin from the burn mound at the Arkwright Dump and (b) the possibility that groundwater flow from the dump may, in fact, contribute to the metals found at SD-04.

RESPONSE: EPA acknowledges, as does the FS, that the Site is a likely source for groundwater and other contaminants in Fairforest creek water, northeast, and southeast, of the Site. In sediment, origins are difficult to pin down. Dioxin was present in the RI background sample, upstream of both IMC and the Site; there are any number of reasonable potential sources for dioxins in the area. The Arkwright Dump Site, with municipal wastes and in view of local accounts of fires, can certainly be a source of dioxins, but EPA believes that attributing specific dioxin detections to specific origins is not possible based on present data (both from the Site and nearby properties). Wind dispersion of contaminants is reasonable to assume, but would equally affect any exposed areas of contaminated soils, including those at higher elevation and away from the Site. Again, there are any number of reasonable potential sources for dioxins in the area, including any areas where burning took place on the ground, for virtually any purpose.

Regarding groundwater flow and contributing metals to sediment sample SD-04, while this may be possible, the idea is not supported by groundwater data from Site wells on the east side of the Site (nearest the creek). The wells do not show any significant metals detections, thus giving no reason to propose the Site as the origin.

Comment No. 14: Although not required for completion of a risk assessment, the Human Health Risk Assessment Report does not include standardized tables consistent with Risk Assessment Guidance for Superfund (RAGS); Standardized Planning, Reporting, and Review of Superfund Risk Assessment (Part D; Interim USEPA, 1998). Please clarify whether approval of this modified approach represents a change in region 4 guidance and practice or is based on site-specific considerations.

RESPONSE: EPA reviews of the drafts, and the finalized, Baseline Risk Assessment recognized the difference between the tables presented and those in the Risk Assessment Guidance for Superfund (RAGS), Part D. As noted, the format is not required for EPA to approve the completion of a risk assessment. Approval was provided for this site only, and does not represent a change in EPA Region 4 risk assessment guidance or policy.

The final five (5) comments concerned the Screening Ecological Risk Assessment Report.

Comment No. 15: Although we generally agree that the approach presented in the document to arrive at preliminary ecological constituents of potential concern (COPCs) represents a reasonable approach to identifying those compounds expected to potentially pose ecological risk, the following screening methodologies do represent a deviation from Region 4 ecological screening guidance, precedence, and practice.

A. Detected constituents without published Region 4 ecological screening values are not maintained as preliminary ecological COPCs.

B. Constituents that were not detected, where the detection limit exceeds a screening value or where no screening value is available, are not maintained as preliminary ecological COPCs.

Please clarify whether approval of these modified screening methodologies represents a change in Region 4 ecological screening guidance and practice or is based on site-specific considerations.

RESPONSE: Comment states that a number of detected constituents were "not maintained as preliminary ecological COPCs." The report has no table listing the preliminary ecological COPCs retained, because EPA did not require the PRP Contractor to prepare an additional report documenting the start of step 3, problem formulation (Guidance section 3). At step 3.2, on page 3-3, all of the constituents with HQs shown in Tables 3, 4, 5, and 6 of the report would have been eliminated ("Refinement of COPCs" step). Based on review by the assigned ecological toxicologist in the Office of Technical Services, the RPM decided to approve the document because it was determined to be sufficient for the necessary risk management and site management decisions to be made. Approval was for this site only, and does not represent a change in EPA Region 4 ecological risk assessment guidance or policy.

Comment No. 16: The text indicates that Van den Berg et al. (1988) was used to assess the toxicity equivalent factors for the dioxin and furan congeners. However, media-specific data tables do not include a presentation of dioxin toxicity equivalent concentrations (TEQs) for mammalian, avian, and fish species.

RESPONSE: The comment is correct, the TEQ values should have been included in the tables.

Comment No. 17: The text indicates that no screening value is available for dioxin/furans in sediment. This is incorrect. Beginning in August 11, 1999, Region 4's Ecological Risk Assessment Bulletins–Supplement to RAGS located at http://www/epa.gov/region4/waste/ots/ecolbul.htm has included an ecological screening value for dioxin in sediment (see Table 3). The dioxin ecological screening value for sediment is 2.5 ng/kg and is taken from *Interim Report on Data and Methods for Assessment of 2,3,7,8 -*

Tetrachlorodibenzo-p-dioxin Risks to Aquatic Life and Associated Wildlife EPA/600/R-93/055 (USEPA, 1993).

RESPONSE: The comment is correct, the screening value is available. The screening value is a toxicity equivalent quotient (TEQs), and should be in the table for each sample.

Comment No. 18: The United States Environmental Protection Agency (USEPA) approval letter, dated September 11, 2002, which accompanies the report documents the scientific management decision point (SMDP) recommended in the ecological risk assessment process following Steps 1 and 2. Please clarify whether the conclusion that "the proposed Site remedy will not need a separate action to address ecosystem restoration" also indicates that additional ecological risk evaluations are not indicated based on the results of the Screening Ecological Risk Assessment activities conducted to date.

RESPONSE: As stated, EPA did not require the PRP Contractor to prepare an additional report documenting the elimination of the constituents with HQs shown in Tables 3, 4, 5, and 6 of the report. The conclusion that no additional ecological risk evaluation was necessary preceded considerations about whether the Site remedy would need to address ecosystem restoration. These decisions apply to this site only, and do not represent a change in EPA Region 4 ecological risk assessment guidance or policy.

Comment No. 19: The USEPA approval letter, dated September 11, 2002, which accompanies the report provides rationale for the SMDP based on surface water considerations and soil considerations (i.e., presumptive remedy). Can the SMDP be supplemented to include the agency's *rationale with respect to sediment considerations?*

RESPONSE: The approval letter itself, dated September 11, 2002, cannot be altered or amended at this time. As noted, the letter focused on surface water and soil considerations, but could have noted a sediment rationale as well. Among the detected constituents, one (chromium) had an HQ >1.0. This constituent also would have been eliminated in the "Refinement of COPCs" step. Conclusions about the lack of significant sediment detections were unchanged.

APPENDIX B
SUPPLEMENTAL RISK ASSESSMENT INFORMATION

RECORD OF DECISION
ARKWRIGHT DUMP SITE, SPARTANBURG, SOUTH CAROLINA
APPENDIX B
SUPPLEMENTAL RISK ASSESSMENT INFORMATION

The tables presented in this appendix are excerpted from the following document:

"Human Health Risk Assessment for Arkwright Dump,"
Fletcher Group, Greenville, SC, September 2002

TABLE 3.1

INCIDENTAL SOIL INGESTION DURING RECREATION

Equation :

$$\text{Intake}\left(\frac{mg}{kg\text{-}day}\right) = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Equation :

- **CS = Contaminant Concentration in Sediment (mg/kg)**
- **IR = Incidental Ingestion Rate of Soil (mg/day)**
- **CF = Conversion factor (10^{-6} kg/mg)**
- **FI = Fraction Ingested (1.0 for surface soil)**
- **EF = Exposure Frequency (days/year)**
- **ED = Exposure Duration (years)**
- **BW = Body Weight (kg)**
- **AT = Averaging Time (period over which exposure is averaged -- days)**

Assumptions:

CA: **Site-specific measured value. Highest concentration.**

IR: **200 mg/day for the child (1-6) [US EPA, 1991b]**
100 mg/day for age groups >6 [US EPA, 1991b]

EF: **78 days/year [2 visits per week – 39 weeks]**

ED: **70 years (lifetime by convention [US EPA, 1991b]**
30 years at one residence for adults [US EPA, 1991b]
6 years for the children (1-6) and (7-12) [US EPA, 1991b]

BW: **15 kg for the child (1-6) [US EPA, 1991b]**
27 kg for the child (1-6) [Assumed]
70 kg for the child [US EPA, 1991b]

AT: **ED x 365 days/year for noncarcinogenic risk**
70 years x 365 days/year for carcinogenic risk

TABLE 3.2

DERMAL ABSORPTION FROM SOIL DURING RECREATION

Equation :

$$\text{Intake}\left(\frac{\text{mg}}{\text{kg-day}}\right) = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Equation :

- **CS = Contaminant Concentration in Soil (mg/kg)**
- **CF = Conversion factor (10^{-6} kg/mg)**
- **SA = Skin Surface Available for Contact (cm^2)**
- **AF = Sediment Adherence Factor (mg/cm^2)**
- **ABS = Dermal Absorption Factor (Unitless)**
- **EF = Exposure Frequency (days/year)**
- **ED = Exposure Duration (years)**
- **BW = Body Weight (kg)**
- **AT = Averaging Time (period over which exposure is averaged -- days)**

Assumptions:

CA: Site-specific measured value. Highest concentration.

SA: 1,780 cm^2 for the child (1-6)
3,020 cm^2 for the child (7-12)
4,720 cm^2 for adult
(50th percentile of ½ legs, ½ arms and hands [US EPA, 1991b]

AF: 0.2 mg/cm^2 [US EPA, 2000c]

ABS: 0.01 for organic compounds [US EPA, 1992]
0.001 for inorganic compounds [US EPA, 1992]

EF: 78 days/year [2 visits per week – 39 weeks]

ED: 70 years (lifetime by convention) [US EPA, 1991b]
30 years at one residence (7-12) [US EPA, 1991b]
6 years for the children (1-6) and (7-12) [US EPA, 1991b]

BW: 15 kg for the child (1-6) [US EPA, 1991b]
27 kg for the child (1-6) [Assumed]
70 kg for the child [US EPA, 1991b]

AT: ED x 365 days/year for noncarcinogenic risk
70 years x 365 days/year for carcinogenic risk

TABLE 3.3

INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS DURING RECREATION

Equation :

$$\text{Intake}\left(\frac{\text{mg}}{\text{kg-day}}\right) = \frac{\text{CA} \times \text{IR} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

Equation :

CA = Contaminant Concentration in Air (mg/M^3)
IR = Inhalation Rate (M^3/hour)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Variable Values:

CA: Site-specific measured or modeled value.

IR: 1.2 M^3/hour child short term moderate [US EPA, 1997e]
1.6 M^3/hour adult short term moderate [US EPA, 1997e]

ET: 2.6 hours/day extrapolated from swimming [US EPA, 1989]

EF: 78 days/year [2 visits per week – 39 weeks]

ED: 6 years for the child (1-6) and (7-12) [US EPA, 1991b]
30 years at one residence (7-12) [US EPA, 1991b]

BW: 27 kg child (7-12) - [Assumed]
70 kg adult [US EPA, 1991b]

AT: ED x 365 days/year for noncarcinogenic risk
70 years x 365 days/year for carcinogenic risk

TABLE 3.4

INCIDENTAL WATER INGESTION WHILE WADING

Equation :

$$\text{Intake}\left(\frac{\text{mg}}{\text{kg-day}}\right)=\frac{CW\times IR\times ET\times EF\times ED}{BW\times AT}$$

Equation :

CW = Contaminant Concentration in Surface Water (mg/L)
IR = Incidental Ingestion Rate of surface water (L/hour)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Assumptions:

CA: Site-specific measured value. Highest concentration.

IR: 0.05 L/hour for the child (7-12) wading extrapolated from swimming [US EPA, 1989]

ET: 2.6 hours/day for the child (7-12) wading [US EPA, 1989]

EF: 45 days/year for the child (7-12) wading extrapolated from swimming [US EPA, 2000c]

ED: 6 years for the child (7-12) [US EPA, 1991b]

BW: 27 kg for the child (7-12) [Assumed]

AT: ED x 365 days/year for noncarcinogenic risk
70 years x 365 days/year for carcinogenic risk

TABLE 3.5

DERMAL ABSORPTION FROM SURFACE WATER WHILE WADING

Equation :

$$\text{Intake}\left(\frac{mg}{kg\text{-}day}\right) = \frac{CW \times SA \times K_p \times CR \times ET \times EF \times ED \times CF}{BW \times AT}$$

Equation :

CW = Contaminant Concentration in Surface Water (mg/L)
SA = Skin Surface Available for Contact (cm^2)
K_p = Chemical-specific dermal permeability coefficient (cm/hr)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
CR = Volumetric conversion factor for water (1 L/1000 cm^3)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Assumptions:

CA: Site-specific measured value. Highest concentration.

SA: 3,020 cm^2 for the child wading (50^{th} percentile of ½ legs, ½ arms and hands for child (9-10) [US EPA, 1991b]

ET: 2.6 hours/day for the child (7-12) wading [US EPA, 1989]

EF: 45 days/year for the child (7-12) wading extrapolated from swimming [US EPA, 2000c]

ED: 6 years for the child (7-12) [US EPA, 1991b]

BW: 27 kg for the child (7-12) [Assumed]

AT: ED x 365 days/year for noncarcinogenic risk
70 years x 365 days/year for carcinogenic risk

K_p: :	**Manganese**	**0.01 cm/hr [US EPA, 1992]**
	Tetrachloroethene	**0.048 cm/hr**
	Dioxins and Furans	**1.4 cm/hr**

TABLE 3.6

INCIDENTAL SEDIMENT INGESTION WHILE WADING

Equation :

$$\text{Intake}\left(\frac{\text{mg}}{\text{kg-day}}\right) = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

Equation :

CS = Contaminant Concentration in Sediment (mg/kg)
IR = Incidental Ingestion Rate of surface water (mg/day)
CF = Conversion factor (10^{-6} kg/mg)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Assumptions:

CA: Site-specific measured value. Highest concentration.

IR: 100 mg/day for the child (7-12) wading [US EPA, 1991b]

EF: 45 days/year for the child (7-12) wading extrapolated from swimming [US EPA, 2000c]

ED: 6 years for the child (7-12) [US EPA, 1991b]

BW: 27 kg for the child (7-12) [Assumed]

AT: ED x 365 days/year for noncarcinogenic risk
70 years x 365 days/year for carcinogenic risk

TABLE 3.7

DERMAL ABSORPTION FROM SEDIMENT WHILE WADING

Equation :

$$\text{Intake}\left(\frac{\text{mg}}{\text{kg-day}}\right) = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Equation :

CS = Contaminant Concentration in Sediment (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
SA = Skin Surface Available for Contact (cm^2)
AF = Sediment Adherence Factor (mg/cm^2)
ABS = Dermal Absorption Factor (Unitless)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Assumptions:

CA: Site-specific measured value. Highest concentration.

SA: 3,020 cm^2 for the child wading (50th percentile of ½ legs, ½ arms and hands for child (9-10) [US EPA, 1991b]

AF: 0.2 mg/cm^2 [US EPA, 2000c]

**ABS: 0.01 for organic compounds [US EPA, 1992]
0.001 for inorganic compounds [US EPA, 1992]**

EF: 45 days/year for the child (7-12) wading extrapolated from swimming [US EPA, 2000c]

ED: 6 years for the child (7-12) [US EPA, 1991b]

BW: 27 kg for the child (7-12) [US EPA, 1991b]

**AT: ED x 365 days/year for noncarcinogenic risk
70 years x 365 days/year for carcinogenic risk**

TABLE 3.8

INGESTION OF GROUNDWATER

Equation :

$$\text{Intake}\left(\frac{\text{mg}}{\text{kg-day}}\right) = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Equation :

CW = Contaminant Concentration in Surface Water (mg/L)
IR = Incidental Ingestion Rate of surface water (L/hour)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Assumptions:

CW: Site-specific measured value. Highest concentration.

IR: 1 L/Day for the child (1-12) [US EPA, 1991b]
2 L/Day for the child (7-12) [US EPA, 1991b]
2 L/Day for the adult [US EPA, 1991b]

EF: 350 days/year
[US EPA, 1991a]

ED: 6 years for the child (1-6) [US EPA, 1991b]
6 years for the child (7-12) [US EPA, 1991b]
18 years for the adult [US EPA, 1991b]

BW: 15 kg for the child (1-6) [US EPA, 1991b]
27 kg for the child (7-12) [Assumed]
70 kg for the child [US EPA, 1991b]

AT: ED x 365 days/year for noncarcinogenic risk
70 years x 365 days/year for carcinogenic risk

TABLE 3.9

DERMAL ABSORPTION FROM GROUNDWATER WHILE SHOWERING

Equation :

$$\text{Intake}\left(\frac{\text{mg}}{\text{kg-day}}\right) = \frac{CW \times SA \times K_p \times ET \times EF \times ED \times CF}{BW \times AT}$$

Equation :

- **CW = Contaminant Concentration in Surface Water (mg/L)**
- **SA = Skin Surface Available for Contact (cm^2)**
- **K_p = Chemical-specific dermal permeability coefficient (cm/hr)**
- **ET = Exposure Time (hours/day)**
- **EF = Exposure Frequency (days/year)**
- **ED = Exposure Duration (years)**
- **CF = Volumetric conversion factor for water (1 L/1000 cm^3)**
- **BW = Body Weight (kg)**
- **AT = Averaging Time (period over which exposure is averaged -- days)**

Assumptions:

CA: **Site-specific measured value. Highest concentration.**

SA: **7,200 cm^2 for the child (1-7) [US EPA, 1989]**
10,500 cm^2 for the child (7-12) [US EPA, 1989]
18,200 cm^2 for the adult [US EPA, 1989]

ET: **0.14 hours/day for the child showering [California EPA, 1994]**
0.25 hours/day for the adult showering [California EPA, 1994]

EF: **350 days/year**

ED: **6 years for the child (1-6) [US EPA, 1991b]**
6 years for the child (7-12) [US EPA, 1991b]
18 years for the adult [US EPA, 1991b]

BW: **15 kg for the child (1-6) [US EPA, 1991b]**
27 kg for the child (7-12) [Assumed]
70 kg for the adult [US EPA, 1991b]

AT: **ED x 365 days/year for noncarcinogenic risk**
70 years x 365 days/year for carcinogenic risk

TABLE 3.10

INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS WHILE SHOWERING

Equation :

$$\text{Intake}\left(\frac{\text{mg}}{\text{kg-day}}\right) = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

Equation :

CA = Contaminant Concentration in Air (mg/M³)
IR = Inhalation Rate (M³/hour)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged – days)

Variable Values:

CA: Site-specific measured concentration in groundwater times the Henry's constant.

IR: 0.6 M³/hr for all groups while showering [US EPA, 1989]

ET: 0.14 hours/day for the child showering [California EPA, 1994]
0.25 hours/day for the adult showering [California EPA, 1994]

EF: 350 days/year

ED: 6 years for the child (1-6) [US EPA, 1991b]
6 years for the child (7-12) [US EPA, 1991b]
18 years for the adult [US EPA, 1991b]

BW: 15 kg for the child (1-6) [US EPA, 1991b]
27 kg for the child (7-12) [Assumed]
70 kg for the adult [US EPA, 1991b]

TABLE 3.11
CHILD (AGE 1-6) EXPOSURE DURATION AVERAGED DOSES
CURRENT RECREATIONAL VISITOR

CHEMICALS	Landfill Gas mg/kg-day	Soil Ingestion mg/kg-day	Soil Absorption mg/kg-day	Total mg/kg-day
Manganese	-	1.42E-03	2.54E-06	1.43E-03
Antimony	-	3.13E-05	5.58E-08	3.14E-05
Arsenic	-	3.42E-05	3.04E-06	3.72E-05
Barium	-	2.08E-03	3.70E-06	2.08E-03
Cadmium	-	6.55E-06	1.17E-08	6.57E-06
Copper	-	1.57E-03	2.79E-06	1.57E-03
Cyanide	-	1.52E-05	2.71E-06	1.80E-05
Selenium	-	1.99E-05	3.55E-08	2.00E-05
Zinc	-	3.42E-03	6.09E-06	3.43E-03
Benzene	7.51E-05	-	-	7.51E-05
Chlorobenzene	1.96E-05	-	-	1.96E-05
Chloroethane	1.20E-07	-	-	1.20E-07
Chloromethane	1.60E-06	-	-	1.60E-06
Dieldrin	-	2.85E-08	2.54E-09	3.10E-08
4,4'-DDT	-	7.86E-08	7.00E-09	8.56E-08
p-Dichlorobenzene	4.13E-06	-	-	4.13E-06
Dichlorodifluoromethane	3.33E-06	-	-	3.33E-06
cis-1,2-Dichloroethene	1.20E-06	-	-	1.20E-06
Ethylbenzene	7.82E-06	-	-	7.82E-06
Methylene Chloride	1.20E-07	-	-	1.20E-07
Tetrachloroethene	1.02E-06	-	-	1.02E-06
Toluene	1.20E-06	-	-	1.20E-06
Trichloroethene	1.24E-05	-	-	1.24E-05
Trichlorofluoromethane	3.02E-07	-	-	3.02E-07
Trimethylbenzene	2.04E-05	-	-	2.04E-05
Vinyl Chloride	5.78E-06	-	-	5.78E-06
Xylenes	2.10E-05	-	-	2.10E-05

TABLE 3.12
CHILD (AGE 7-12) EXPOSURE DURATION AVERAGED DOSES
CURRENT RECREATIONAL VISITOR

CHEMICALS	Landfill Gas mg/kg-day	Surface Water Ingestion mg/kg-day	Surface Water Absorption mg/kg-day	Sediment Ingestion mg/kg-day	Sediment Absorption mg/kg-day	Soil Ingestion mg/kg-day	Soil Absorption mg/kg-day	Total mg/kg-day
Manganese	-	9.50E-05	5.74E-05	-	-	3.96E-04	2.39E-06	5.50E-04
Antimony	-	-	-	-	-	8.71E-06	5.26E-08	8.76E-06
Arsenic	-	-	-	2.37×10^{-6}	1.43×10^{-8}	9.50E-06	2.87E-06	1.48×10^{-5}
Barium	-	-	-	-	-	5.78E-04	3.49E-06	5.81E-04
Cadmium	-	-	-	-	-	1.82E-06	1.10E-08	1.83E-06
Copper	-	-	-	-	-	4.35E-04	2.63E-06	4.38E-04
Chromium	-	-	-	4.57×10^{-5}	2.67×10^{-7}	-	-	4.59×10^{-5}
Cyanide	-	-	-	-	-	4.23E-06	2.56E-06	6.79E-06
Selenium	-	-	-	-	-	5.54E-06	3.35E-08	5.57E-06
Zinc	-	-	-	-	-	9.50E-04	5.74E-06	9.56E-04
Benzene	4.17E-05	-	-	-	-	-	-	4.17E-05
Chlorobenzene	1.09E-05	-	-	-	-	-	-	1.09E-05
Chloroethane	6.67E-08	-	-	-	-	-	-	6.67E-08
Chloromethane	8.89E-07	-	-	-	-	-	-	8.89E-07
Dieldrin	-	-	-	-	-	7.91E-09	2.39E-09	1.03E-08
4,4'-*DDT*	-	-	-	-	-	2.18E-08	6.60E-09	2.84E-08
p-Dichlorobenzene	2.30E-06	-	-	-	-	-	-	2.30E-06
Dichlorodifluoromethane	1.85E-06	-	-	-	-	-	-	1.85E-06
cis-1,2-Dichloroethene	6.67E-07	-	-	-	-	-	-	6.67E-07
Ethylbenzene	4.35E-06	-	-	-	-	-	-	4.35E-06
Methylene Chloride	6.67E-08	-	-	-	-	-	-	6.67E-08
Tetrachloroethene	5.68E-07	1.19E-06	3.44E-06	-	-	-	-	5.20E-06
Toluene	6.67E-07	-	-	-	-	-	-	6.67E-07
Trichloroethene	6.91E-06	-	-	-	-	-	-	6.91E-06
Trichlorofluoromethane	1.68E-07	-	-	-	-	-	-	1.68E-07
Trimethylbenzene	1.14E-05	-	-	-	-	-	-	1.14E-05
Vinyl Chloride	3.21E-06	-	-	-	-	-	-	3.21E-06
Xylenes	1.17E-05	-	-	-	-	-	-	1.17E-05

TABLE 3.13
ADULT EXPOSURE DURATION AVERAGED DOSES
CURRENT RECREATIONAL VISITOR

CHEMICALS	Landfill Gas mg/kg-day	Soil Ingestion mg/kg-day	Soil Absorption mg/kg-day	Total mg/kg-day
Manganese	-	1.53E-04	1.44E-06	1.54E-04
Antimony	-	3.36E-06	3.17E-08	3.39E-06
Arsenic	-	3.66E-06	1.73E-06	5.39E-06
Barium	-	2.23E-04	2.10E-06	2.25E-04
Cadmium	-	7.02E-07	6.63E-09	7.09E-07
Copper	-	1.68E-04	1.59E-06	1.69E-04
Cyanide	-	1.63E-06	1.54E-06	3.18E-06
Selenium	-	2.14E-06	2.02E-08	2.16E-06
Zinc	-	3.66E-04	3.46E-06	3.70E-04
Benzene	2.15E-05	-	-	2.15E-05
Chlorobenzene	5.59E-06	-	-	5.59E-06
Chloroethane	3.43E-08	-	-	3.43E-08
Chloromethane	4.57E-07	-	-	4.57E-07
Dieldrin	-	3.05E-09	1.44E-09	4.49E-09
4,4'-DDT	-	8.43E-09	3.98E-09	1.24E-08
p-Dichlorobenzene	1.18E-06	-	-	1.18E-06
Dichlorodifluoromethane	9.52E-07	-	-	9.52E-07
cis-1,2-Dichloroethene	3.43E-07	-	-	3.43E-07
Ethylbenzene	2.24E-06	-	-	2.24E-06
Methylene Chloride	3.43E-08	-	-	3.43E-08
Tetrachloroethene	2.92E-07	-	-	2.92E-07
Toluene	3.43E-07	-	-	3.43E-07
Trichloroethene	3.56E-06	-	-	3.56E-06
Trichlorofluoromethane	8.64E-08	-	-	8.64E-08
Trimethylbenzene	5.84E-06	-	-	5.84E-06
Vinyl Chloride	1.65E-06	-	-	1.65E-06
Xylenes	5.99E-06	-	-	5.99E-06

TABLE 3.14
LIFETIME AVERAGED EXPOSURE DOSES
CURRENT RECREATIONAL VISITOR

CHEMICALS	Landfill Gas mg/kg-day	Surface Water Ingestion mg/kg-day	Surface Water Absorption mg/kg-day	Sediment Ingestion mg/kg-day	Sediment Absorption mg/kg-day	Soil Ingestion mg/kg-day	Soil Absorption mg/kg-day	Total mg/kg-day
Arsenic	-	-	-	2.04×10^{-7}	1.23×10^{-9}	1.57E-06	7.41E-07	2.05×10^{-7}
2,3,7,8-TCDD Equivalents	-	7.12E-15	2.07E-14	-	-	5.29E-11	1.50E-11	6.78E-11
Benzo(a)pyrene Equivalents	-	-	-	-	-	9.63E-08	1.36E-07	0.00E+00
Benzene	9.20E-06	-	-	-	-	-	-	9.20E-06
Chloroethane	1.47E-08	-	-	-	-	-	-	1.47E-08
Chloromethane	1.96E-07	-	-	-	-	-	-	1.96E-07
4,4'-DDT	-	-	-	-	-	3.61E-09	1.70E-09	5.32E-09
4,4'-DDE	-	-	-	-	-	7.59E-10	3.58E-10	1.12E-09
Ethylbenzene	9.58E-07	-	-	-	-	-	-	9.58E-07
p-Dichlorobenzene	5.06E-07	-	-	-	-	-	-	5.06E-07
Methylene Chloride	1.47E-08	-	-	-	-	-	-	1.47E-08
Tetrachloroethene	1.25E-07	1.02E-07	2.95E-07	-	-	-	-	5.22E-07
Trichloroethene	1.52E-06	-						1.52E-06
Vinyl Chloride	7.08E-07	-	-	-	-	-	-	7.08E-07

TABLE 3.15
CHILD (AGE 1-6) EXPOSURE DURATION AVERAGED DOSES
RECREATIONAL VISITOR

CHEMICALS	Inhalation of VOCs mg/kg-day
Benzene	7.51E-05
Chlorobenzene	1.96E-05
Chloroethane	1.20E-07
Chloromethane	1.60E-06
p -Dichlorobenzene	4.13E-06
Dichlorodifluoromethane	3.33E-06
cis -1,2-Dichloroethene	1.20E-06
Ethylbenzene	7.82E-06
Methylene Chloride	1.20E-07
Tetrachloroethene	1.02E-06
Toluene	1.20E-06
Trichloroethene	1.24E-05
Trichlorofluoromethane	3.02E-07
Trimethylbenzene	2.04E-05
Vinyl Chloride	5.78E-06
Xylenes	2.10E-05

TABLE 3.16
CHILD (AGE 7-12) EXPOSURE DURATION AVERAGED DOSES
FUTURE RECREATIONAL VISITOR

CHEMICALS	Landfill Gas mg/kg-day	Surface Water Ingestion mg/kg-day	Surface Water Absorption mg/kg-day	Sediment Ingestion mg/kg-day	Sediment Absorption mg/kg-day	Total mg/kg-day
Manganese	-	9.50E-05	5.74E-05	-	-	1.52E-04
Arsenic	-	-	-	2.37×10^{-6}	1.38E-11	2.37×10^{-6}
Chromium	-	-	-	4.57×10^{-5}	1.43E-09	4.57×10^{-5}
Benzene	4.17E-05	-	-	-	-	4.17E-05
Chlorobenzene	1.09E-05	-	-	-	-	1.09E-05
Chloroethane	6.67E-08	-	-	-	-	6.67E-08
Chloromethane	8.89E-07	-	-	-	-	8.89E-07
p -Dichlorobenzene	2.30E-06	-	-	-	-	2.30E-06
Dichlorodifluoromethane	1.85E-06	-	-	-	-	1.85E-06
cis -1,2-Dichloroethene	6.67E-07	-	-	-	-	6.67E-07
Ethylbenzene	4.35E-06	-	-	-	-	4.35E-06
Methylene Chloride	6.67E-08	-	-	-	-	6.67E-08
Tetrachloroethene	5.68E-07	1.19E-06	3.44E-06	-	-	5.20E-06
Toluene	6.67E-07	-	-	-	-	6.67E-07
Trichloroethene	6.91E-06	-	-	-	-	6.91E-06
Trichlorofluoromethane	1.68E-07	-	-	-	-	1.68E-07
Trimethylbenzene	1.14E-05	-	-	-	-	1.14E-05
Vinyl Chloride	3.21E-06	-	-	-	-	3.21E-06
Xylenes	1.17E-05	-	-	-	-	1.17E-05

TABLE 3.17
ADULT EXPOSURE DURATION AVERAGED DOSES
FUTURE RECREATIONAL VISITOR

CHEMICALS	Inhalation of VOCs mg/kg-day
Benzene	2.15E-05
Chlorobenzene	5.59E-06
Chloroethane	3.43E-08
Chloromethane	4.57E-07
p -Dichlorobenzene	1.18E-06
Dichlorodifluoromethane	9.52E-07
cis -1,2-Dichloroethene	3.43E-07
Ethylbenzene	2.24E-06
Methylene Chloride	3.43E-08
Tetrachloroethene	2.92E-07
Toluene	3.43E-07
Trichloroethene	3.56E-06
Trichlorofluoromethane	8.64E-08
Trimethylbenzene	5.84E-06
Vinyl Chloride	1.65E-06
Xylenes	5.99E-06

TABLE 3.18
LIFETIME AVERAGED DOSES
FUTURE RECREATIONAL VISITOR

CHEMICALS	Landfill Gas mg/kg-day	Surface Water Ingestion mg/kg-day	Surface Water Absorption mg/kg-day	Sediment Ingestion mg/kg-day	Sediment Absorption mg/kg-day	Total mg/kg-day
Arsenic	-	-	-	2.04×10^{-7}	1.23×10^{-9}	2.05×10^{-7}
2,3,7,8-TCDD Equivalents	-	7.12E-15	2.07E-14	-	-	2.78E-14
Benzene	9.20E-06	-	-	-	-	9.20E-06
Chloroethane	1.47E-08	-	-	-	-	1.47E-08
Chloromethane	1.96E-07	-	-	-	-	1.96E-07
Ethylbenzene	9.58E-07	-	-	-	-	9.58E-07
p-Dichlorobenzene	5.06E-07	-	-	-	-	5.06E-07
Methylene Chloride	1.47E-08	-	-	-	-	1.47E-08
Tetrachloroethene	1.25E-07	1.02E-07	2.95E-07	-	-	5.22E-07
Trichloroethene	1.52E-06	-	-	-	-	1.52E-06
Vinyl chloride	7.08E-07	-	-	-	-	7.08E-07

TABLE 3.19
CHILD (AGE 1-6) EXPOSURE DURATION AVERAGED DOSES
FUTURE OFF-SITE RESIDENT

CHEMICALS	Groundwater Ingestion mg/kg-day	Inhalation of VOCs mg/kg-day	Dermal Absorption mg/kg-day	Total mg/kg-day
Arsenic	3.20E-04	0.000E+00	9.67E-06	3.29E-04
Barium	3.32E-02	0.000E+00	3.35E-04	3.36E-02
Chromium	1.73E-03	0.000E+00	1.74E-05	1.74E-03
Iron	2.49E+00	0.000E+00	2.51E-02	2.52E+00
Manganese	3.39E-01	0.000E+00	3.42E-03	3.42E-01
Benzene	3.20E-03	6.106E-02	6.77E-05	6.43E-02
Chlorobenzene	1.09E-03	1.408E-02	4.49E-05	1.52E-02
Chloroform	1.15E-04	1.451E-03	1.03E-06	1.57E-03
1,3-Dichlorobenzene	5.11E-04	4.920E-03	4.48E-05	5.48E-03
1,4-Dichlorobenzene	5.75E-04	5.337E-03	3.60E-05	5.95E-03
1,1-Dichloroethene	4.67E-04	4.185E-02	7.53E-06	4.23E-02
cis-Dichloroethene	1.85E-02	2.146E-01	1.87E-04	2.33E-01
trans-Dichloroethene	1.73E-03	3.985E-02	1.74E-05	4.16E-02
Methylene chloride	3.20E-04	3.569E-03	1.45E-06	3.89E-03
Naphthalene	2.62E-03	4.349E-03	1.82E-04	7.15E-03
n-Propylbenzene	5.11E-04	1.845E-02	5.16E-07	1.90E-02
Tetrachloroethene	6.00E-02	3.646E+00	2.90E-03	3.71E+00
Trichloroethene	1.47E-02	5.051E-01	2.37E-04	5.20E-01
1,2,4-Trimethylbenzene	8.31E-04	1.759E-02	8.38E-05	1.85E-02
1,3,5-Trimethylbenzene	2.56E-04	7.704E-03	2.58E-05	7.99E-03
Vinyl Chloride	2.49E-03	4.797E-01	1.83E-05	4.82E-01
o-Xylene	3.20E-04	7.687E-03	2.58E-05	8.03E-03
p-Xylene	1.92E-04	4.612E-03	1.55E-05	4.82E-03

TABLE 3.20
CHILD (AGE 7-12) EXPOSURE DURATION AVERAGED DOSES
FUTURE OFF-SITE RESIDENT

CHEMICALS	Groundwater Ingestion mg/kg-day	Inhlation of VOCs mg/kg-day	Dermal Absorption mg/kg-day	Total mg/kg-day
Arsenic	3.55E-04	0.000E+00	7.83E-06	3.63E-04
Barium	3.69E-02	0.000E+00	2.71E-04	3.72E-02
Chromium	1.92E-03	0.000E+00	1.41E-05	1.93E-03
Iron	2.77E+00	0.000E+00	2.04E-02	2.79E+00
Manganese	3.76E-01	0.000E+00	2.77E-03	3.79E-01
Benzene	3.55E-03	3.392E-02	5.48E-05	3.75E-02
Chlorobenzene	1.21E-03	7.820E-03	3.64E-05	9.06E-03
Chloroform	1.28E-04	8.060E-04	8.36E-07	9.35E-04
1,3-Dichlorobenzene	5.68E-04	2.733E-03	3.63E-05	3.34E-03
1,4-Dichlorobenzene	6.39E-04	2.965E-03	2.91E-05	3.63E-03
1,1-Dichloroethene	5.19E-04	2.325E-02	6.10E-06	2.38E-02
cis -Dichloroethene	2.06E-02	1.192E-01	1.51E-04	1.40E-01
trans -Dichloroethene	1.92E-03	2.214E-02	1.41E-05	2.41E-02
Methylene chloride	3.55E-04	1.983E-03	1.17E-06	2.34E-03
Naphthalene	2.91E-03	2.416E-03	1.48E-04	5.48E-03
n -Propylbenzene	5.68E-04	1.025E-02	4.18E-07	1.08E-02
Tetrachloroethene	6.66E-02	2.026E+00	2.35E-03	2.09E+00
Trichloroethene	1.63E-02	2.806E-01	1.92E-04	2.97E-01
1,2,4-Trimethylbenzene	9.23E-04	9.771E-03	6.79E-05	1.08E-02
1,3,5-Trimethylbenzene	2.84E-04	4.280E-03	2.09E-05	4.59E-03
Vinyl Chloride	2.77E-03	2.665E-01	1.49E-05	2.69E-01
o -Xylene	3.55E-04	4.271E-03	2.09E-05	4.65E-03
p -Xylene	2.13E-04	2.562E-03	1.25E-05	2.79E-03

TABLE 3.21
ADULT EXPOSURE DURATION AVERAGED DOSES
FUTURE OFF-SITE RESIDENT

CHEMICALS	Groundwater Ingestion mg/kg-day	Inhalation of VOCs mg/kg-day	Dermal Absorption mg/kg-day	Total mg/kg-day
Arsenic	1.37E-04	0.000E+00	9.35E-06	1.46E-04
Barium	1.42E-02	0.000E+00	3.24E-04	1.46E-02
Chromium	7.40E-04	0.000E+00	1.68E-05	7.57E-04
Iron	1.07E+00	0.000E+00	2.43E-02	1.09E+00
Manganese	1.45E-01	0.000E+00	3.30E-03	1.49E-01
Benzene	1.37E-03	2.336E-02	6.54E-05	2.48E-02
Chlorobenzene	4.66E-04	5.386E-03	4.34E-05	5.90E-03
Chloroform	4.93E-05	5.552E-04	9.99E-07	6.05E-04
1,3-Dichlorobenzene	2.19E-04	1.883E-03	4.34E-05	2.15E-03
1,4-Dichlorobenzene	2.47E-04	2.042E-03	3.48E-05	2.32E-03
1,1-Dichloroethene	2.00E-04	1.601E-02	7.28E-06	1.62E-02
cis -Dichloroethene	7.95E-03	8.213E-02	1.81E-04	9.03E-02
trans -Dichloroethene	7.40E-04	1.525E-02	1.68E-05	1.60E-02
Methylene chloride	1.37E-04	1.366E-03	1.40E-06	1.50E-03
Naphthalene	1.12E-03	1.664E-03	1.76E-04	2.96E-03
n -Propylbenzene	2.19E-04	7.059E-03	4.99E-07	7.28E-03
Tetrachloroethene	2.57E-02	1.395E+00	2.81E-03	1.42E+00
Trichloroethene	6.30E-03	1.933E-01	2.29E-04	2.00E-01
1,2,4-Trimethylbenzene	3.56E-04	6.730E-03	8.10E-05	7.17E-03
1,3,5-Trimethylbenzene	1.10E-04	2.948E-03	2.49E-05	3.08E-03
Vinyl Chloride	1.07E-03	1.835E-01	1.77E-05	1.85E-01
o -Xylene	1.37E-04	2.941E-03	2.49E-05	3.10E-03
p -Xylene	8.22E-05	1.765E-03	1.50E-05	1.86E-03

TABLE 3.22
LIFETIME - AVERAGED DOSES
FUTURE OFF SITE RESIDENT

CHEMICALS	Groundwater Ingestion mg/kg-day	Inhlation of VOCs mg/kg-day	Dermal Absorption mg/kg-day	Total
Arsenic	5.87E-05	-	1.14E-08	5.87E-05
Benzene	5.87E-04	1.001E-02	8.01E-08	1.06E-02
Chloroform	2.11E-05	2.379E-04	1.22E-09	2.59E-04
1,4-Dichlorobenzene	1.06E-04	8.752E-04	4.26E-08	9.81E-04
1,1-Dichloroethene	8.57E-05	6.862E-03	8.91E-09	6.95E-03
Methylene chloride	5.87E-05	5.853E-04	1.72E-09	6.44E-04
Tetrachloroethene	1.10E-02	5.980E-01	1.20E-03	6.10E-01
Trichloroethene	2.70E-03	8.284E-02	2.81E-07	8.55E-02
Vinyl Chloride	4.58E-04	7.866E-02	2.17E-08	7.91E-02
2,3,7,8-TCDD Equivalents	8.69E-12	1.786E-13	1.69E-15	8.87E-12
alpha-BHC (*a*-HCH)	2.00E-06	4.225E-09	6.49E-10	2.00E-06
beta-BHC (*b*-HCH)	9.75E-06	1.166E-07	3.17E-09	9.87E-06
Arochlor 1242	1.70E-05	2.037E-07	5.53E-09	1.72E-05

TABLE 5.7
CHILD (AGE 1-6) HAZARD QUOTIENTS
FUTURE OFF-SITE RESIDENT

CHEMICALS	Hazard Quotient Ingestion	Hazard Quotient Inhalation	Hazard Quotient Adsorption	Total
Arsenic	1.07	0.00	3.22E-02	1.10
Barium	0.47	0.00	4.79E-03	0.48
Chromium	0.58	0.00	4.46E-01	1.02
Iron	8.31	0.00	8.38E-02	8.39
Manganese	14.12	0.00	3.56E+00	17.67
Benzene	1.07	35.92	2.26E-02	37.00
Chlorobenzene	0.05	0.70	2.25E-03	0.76
Chloroform	0.01	16.12	1.03E-04	16.13
1,3-Dichlorobenzene	0.06	0.55	4.98E-03	0.61
1,4-Dichlorobenzene	0.02	0.02	1.20E-03	0.04
1,1-Dichloroethene	0.05	4.65	8.36E-04	4.70
cis -Dichloroethene	1.85	21.46	1.87E-02	23.34
trans -Dichloroethene	0.09	1.99	8.70E-04	2.08
Methylene chloride	0.01	0.04	2.42E-05	0.05
Naphthalene	0.13	5.06	9.11E-03	5.20
n -Propylbenzene	0.05	1.84	5.16E-05	1.90
Tetrachloroethene	6.00	121.55	2.90E-01	127.83
Trichloroethene	2.45	89.09	3.95E-02	91.58
1,2,4-Trimethylbenzene	0.02	10.17	1.68E-03	10.18
1,3,5-Trimethylbenzene	0.01	4.45	5.16E-04	4.46
Vinyl Chloride	0.83	4.80	6.12E-03	5.63
o -Xylene	0.00	0.00	1.29E-05	0.00
p -Xylene	0.00	0.00	7.73E-06	0.00
Total				**360**

TABLE 5.8
CHILD (AGE 7-12) HAZARD QUOTIENTS
FUTURE OFF-SITE RESIDENT

CHEMICALS	Hazard Quotient Ingegtion	Hazard Quotient Inhalation	Hazard Quotient Adsorption	Total
Arsenic	1.18	0.00	2.61E-02	1.21
Barium	0.53	0.00	3.88E-03	0.53
Chromium	0.64	0.00	3.61E-01	1.00
Iron	9.23	0.00	6.79E-02	9.30
Manganese	15.69	0.00	2.88E+00	18.57
Benzene	1.18	19.95	1.83E-02	21.16
Chlorobenzene	0.06	0.39	1.82E-03	0.45
Chloroform	0.01	8.96	8.36E-05	8.97
1,3-Dichlorobenzene	0.06	0.30	4.04E-03	0.37
1,4-Dichlorobenzene	0.02	0.01	9.71E-04	0.04
1,1-Dichloroethene	0.06	2.58	6.78E-04	2.64
cis -Dichloroethene	2.06	11.92	1.51E-02	14.00
trans -Dichloroethene	0.10	1.11	7.05E-04	1.20
Methylene chloride	0.01	0.00	1.96E-05	0.01
Naphthalene	0.15	2.81	7.38E-03	2.96
n -Propylbenzene	0.06	1.02	4.18E-05	1.08
Tetrachloroethene	6.66	67.53	2.35E-01	74.42
Trichloroethene	2.72	49.49	3.20E-02	52.25
1,2,4-Trimethylbenzene	0.02	5.65	1.36E-03	5.67
1,3,5-Trimethylbenzene	0.01	2.47	4.18E-04	2.48
Vinyl Chloride	0.92	2.66	4.95E-03	3.59
o -Xylene	0.00	0.00	1.04E-05	0.00
p -Xylene	0.00	0.00	6.26E-06	0.00
Total				**222**

TABLE 5.9
ADULT HAZARD QUOTIENTS
FUTURE OFF-SITE RESIDENT

CHEMICALS	Hazard Quotient Ingegtion	Hazard Quotient Inhalation	Hazard Quotient Adsorption	Total
Arsenic	0.46	0.00	3.12E-02	0.49
Barium	0.20	0.00	4.63E-03	0.21
Chromium	0.25	0.00	4.32E-01	0.68
Iron	3.56	0.00	8.10E-02	3.64
Manganese	6.05	0.00	3.44E+00	9.49
Benzene	0.46	13.74	2.18E-02	14.22
Chlorobenzene	0.02	0.27	2.17E-03	0.29
Chloroform	0.00	6.17	9.99E-05	6.17
1,3-Dichlorobenzene	0.02	0.21	4.82E-03	0.24
1,4-Dichlorobenzene	0.01	0.01	1.16E-03	0.02
1,1-Dichloroethene	0.02	1.78	8.09E-04	1.80
cis -Dichloroethene	0.79	8.21	1.81E-02	9.03
trans -Dichloroethene	0.04	0.76	8.41E-04	0.80
Methylene chloride	0.00	0.02	2.34E-05	0.02
Naphthalene	0.06	1.94	8.82E-03	2.00
n -Propylbenzene	0.02	0.71	4.99E-05	0.73
Tetrachloroethene	2.57	46.51	2.81E-01	49.36
Trichloroethene	1.05	34.09	3.82E-02	35.18
1,2,4-Trimethylbenzene	0.01	3.89	1.62E-03	3.90
1,3,5-Trimethylbenzene	0.00	1.70	4.99E-04	1.71
Vinyl Chloride	0.36	1.84	5.92E-03	2.20
o -Xylene	0.00	0.00	1.25E-05	0.00
p -Xylene	0.00	0.00	7.48E-06	0.00
Total				**142**

TABLE 5.10
LIFETIME AVERAGED CARCINOGENIC RISK
CURRENT RECREATIONAL VISITOR

CHEMICALS	Landfill Gas Risk	Surface Water Ingestion Risk	Surface Water Absorption Risk	Sediment Ingestion Risk	Sediment Absorption Risk	Soil Ingestion Risk	Soil Absorption Risk	Total Carcinogenic Risk
Arsenic	-	-	-	3.05×10^{-7}	1.84×10^{-9}	2.36E-06	1.12E-06	3.48E-06
2,3,7,8-TCDD Equivalents	-	1.07E-09	3.10E-09	-	-	7.93E-06	2.27E-06	1.02E-05
Benzo(a)pyrene Equivalents	-	-	-	-	-	7.08E-07	1.01E-06	1.72E-06
Benzene	2.51E-07	-	-	-	-	-	-	2.51E-07
Chloroethane	4.26E-11	-	-	-	-	-	-	4.26E-11
Chloromethane	1.23E-09	-	-	-	-	-	-	1.23E-09
4,4'-DDT	-	-	-	-	-	1.23E-09	1.23E-10	1.35E-09
4,4'-DDE	-	-	-	-	-	2.58E-10	1.12E-06	1.12E-06
Ethylbenzene	3.64E-09	-	-	-	-	-	-	3.64E-09
p-Dichlorobenzene	1.21E-08	-	-	-	-	-	-	1.21E-08
Methylene Chloride	2.35E-11	-	-	-	-	-	-	2.35E-11
Tetrachloroethene	2.50E-10	5.29E-09	1.53E-08	-	-	-	-	2.09E-08
Trichloroethene	9.14E-09	-	-	-	-	-	-	9.14E-09
Vinyl Chloride	2.19E-08	-	-	-	-	-	-	
Total								**1.68E-05**

TABLE 5.12
LIFETIME CARCINOGENIC RISK - GROUNDWATER
FUTURE OFF SITE RESIDENT

CHEMICALS	Carcinogenic Risk Ingestion	Carcinogenic Risk Inhalation	Carcinogenic Risk Adsorption	Total
Arsenic	8.81E-05	0.000E+00	1.72E-08	8.81E-05
Benzene	3.23E-05	2.734E-04	4.41E-09	3.06E-04
Chloroform	1.29E-07	1.927E-05	7.46E-12	1.94E-05
1,4-Dichlorobenzene	2.54E-06	2.101E-05	1.02E-09	2.35E-05
1,1-Dichloroethene	5.14E-05	1.235E-03	5.35E-09	1.29E-03
Methylene chloride	4.40E-07	9.365E-07	1.29E-11	1.38E-06
Tetrachloroethene	5.73E-04	1.196E-03	6.25E-05	1.83E-03
Trichloroethene	2.97E-05	4.970E-04	3.09E-09	5.27E-04
Vinyl Chloride	6.87E-04	2.439E-03	3.26E-08	3.13E-03
2,3,7,8-TCDD Equivalents	1.30E-06	2.679E-08	2.54E-10	1.33E-06
alpha-BHC (*a* -HCH)	1.26E-05	2.662E-08	4.09E-09	1.26E-05
beta-BHC (*b* -HCH)	1.75E-05	2.099E-07	5.70E-09	1.78E-05
Arochlor 1242	1.70E-05	2.037E-07	8.30E-09	1.72E-05
Total				**7.26E-03**

Carcinogenic Soil Risk - Arkwright Landfill, Spartanburg, South Carolina

Ingestion and Dermal Contact
Current Recreational Use
Lifetime

C_f =	1E-06	kg/mg
S_a =	4,720	cm²/day
F_{adh} =	0.2	mg/cm²
F_{exp} =	78	days/year
F_{con} =	1.00	Surface Soil
D_{exp} (NC) =	30	years
W_b =	70	kg
T_{avg} =	10,950	days (NC)
ABS		
Chl Pest	0.05	
PNA	0.15	
CDD&CDI	0.03	
Org chem	0.15	
Free CN	0.10	
As	0.05	
Cd	0.00	
Cr	0.00	
Metals	0.001	

	MW	C_s mg/kg	Intake Ingestion mg/kg day	Intake Dermal Abs mg/kg day	Total mg/kg day	SF_o Slope Factor (kg day)/mg		ABS	Source	SF_d Slope Factor (kg day)/mg	Injestion SF_o*Oral Intake	Absorption SF_o*Oral Intake + SFd *Dermal Abs	Contact Risk SF_o*Oral Intake + SFd *Dermal Abs
SOIL													
2,3,7,8-TCDD Equivalents	322.0	0.00040	5.29E-11	1.50E-11	6.78E-11	1.5E+05	HEAST	>50%	RAGS (Pt E)	1.50E+05	7.93E-06	2.25E-06	1.017E-05
Benzo(a)pyrene Equivalents	252.3	0.736	9.63E-08	1.36E-07	2.33E-07	7.4E+00	IRIS	>50%	RAGS (Pt E)	7.35E+00	7.08E-07	1.00E-06	1.710E-06
4,4'-DDT	354.5	0.0276	3.61E-09	1.70E-09	5.32E-09	3.4E-01	IRIS	>50%	RAGS (Pt E)	3.40E-01	1.23E-09	5.80E-10	1.807E-09
4-4'-DDE	318.0	0.0058	7.59E-10	3.58E-10	1.12E-09	3.4E-01	IRIS	>50%	ASTDR	3.40E-01	2.58E-10	1.22E-10	3.798E-10
Arsenic	74.9	12.0	1.57E-06	7.41E-07	2.31E-06	1.5E+00	IRIS	>50%	RAGS (Pt E)	1.50E+00	2.36E-06	1.11E-06	3.467E-06
						Total							1.5E-05

Noncarciongenic Risk for Groundwater Exposure - Arkwright Landfill, Sparta

Child (1-6)
Future Off-Site Resident

			5,300			Ingestion		Hazard			Inhalation	
						RfD_o	Hazard	HSDB			RfD_i	H
			C_w	C_w	Intake	Ref. Dose	Quotient	H x (10^3)	C_a	Intake	Ref. Dose	Q
		MW	µg/L	mg/L	mg/kg day	mg/(kg day)	Intake/R_fD_o	M^3-atm/mol	mg/M^3	mg/kg day	mg/(kg day)	Inta
	GROUNDWATER											
	Arsenic	74.9	5.0	0.0050	3.20E-04	3.00E-04	1.065	0.00	0.00	0.000E+00	3.00E-04	C
day	Barium	137.3	520	0.5200	3.32E-02	7.00E-02	0.475	0.00	0.00	0.000E+00	7.00E-02	C
	Chromium	52.0	27	0.0270	1.73E-03	3.00E-03	0.575	0.00	0.00	0.000E+00	3.00E-03	C
	Iron	55.8	39,000	39.0000	2.49E+00	3.00E-01	8.311	0.00	0.00	0.000E+00	3.00E-01	C
ar	Manganese	54.9	5,300	5.3000	3.39E-01	2.40E-02	14.117	0.00	0.00	0.000E+00	2.40E-02	C
	Benzene	78.1	50.00	0.0500	3.20E-03	3.00E-03	1.065	5.56	11.37	6.106E-02	1.70E-03	3
	Chlorobenzene	112.6	17	0.0170	1.09E-03	0.02	0.054	3.77	2.62	1.408E-02	2.00E-02	C
:in)	Chloroform	119.4	1.80	0.0018	1.15E-04	1.0E-02	0.012	3.67	0.27	1.451E-03	9.00E-05	1
	1,3-Dichlorobenzene	147.0	8.00	0.0080	5.11E-04	9.0E-03	0.057	2.80	0.92	4.920E-03	9.00E-03	C
	1,4-Dichlorobenzene	147.0	9.0	0.0090	5.75E-04	3.0E-02	0.019	2.70	0.99	5.337E-03	2.30E-01	C
	1,1-Dichloroethene	96.9	7.30	0.0073	4.67E-04	9.0E-03	0.052	26.10	7.79	4.185E-02	9.00E-03	4
	cis-Dichloroethene	96.9	290.00	0.2900	1.85E-02	1.0E-02	1.854	3.37	39.97	2.146E-01	1.00E-02	2
	trans-Dichloroethene	96.9	27.00	0.0270	1.73E-03	2.0E-02	0.086	6.72	7.42	3.985E-02	2.00E-02	1
	Methylene chloride	84.9	5.0	0.0050	3.20E-04	6.0E-02	0.005	3.25	0.66	3.569E-03	8.60E-02	C
	Naphthalene	128.2	41.0	0.0410	2.62E-03	2.0E-02	0.131	0.48	0.81	4.349E-03	8.60E-04	5
	n-Propylbenzene	120.2	8.0	0.0080	5.11E-04	1.0E-02	0.051	10.50	3.44	1.845E-02	1.00E-02	1
	Tetrachloroethene	165.8	938	0.9380	6.00E-02	1.0E-02	5.996	17.70	679.04	3.646E+00	3.00E-02	12
	Trichloroethene	131.4	230	0.2300	1.47E-02	6.0E-03	2.451	10.00	94.07	5.051E-01	5.67E-03	8
	1,2,4-Trimethylbenzene	120.2	13	0.0130	8.31E-04	5.0E-02	0.017	6.16	3.28	1.759E-02	1.73E-03	1
	1,3,5-Trimethylbenzene	120.2	4	0.0040	2.56E-04	5.0E-02	0.005	8.77	1.43	7.704E-03	1.73E-03	4
	Vinyl Chloride	62.5	39	0.0390	2.49E-03	3.0E-03	0.831	56.00	89.33	4.797E-01	1.00E-01	4
	o-Xylene	106.2	5	0.0050	3.20E-04	2.0E+00	0.000	7.00	1.43	7.687E-03	2.00E+00	C
	p-Xylene	106.2	3	0.0030	1.92E-04	2.0E+00	0.000	7.00	0.86	4.612E-03	2.00E+00	C

er Exposure - Arkwright Landfill, Spartanburg, South Carolina

Child (1-6)
Future Off-Site Resident

azard iotient ke/R_fD_o	Hazard HSDB H x (10^3) M^2-atm/mol	C_a mg/M^3	Intake mg/kg day	Inhalation RfD_i Ref. Dose mg/(kg day)	Hazard Quotient Intake/R_fD_i	Kp cm/hr	Intake mg/kg day	ABS	Absorption RfD_a Ref Dose mg/(kg day)	Hazard Quotient Intake/R_fD_a	Total Hazard Quotient	% Ri
.065	0.00	0.00	0.000E+00	3.00E-04	0.000	3.00E-02	9.67E-06	1.0	3.00E-04	3.22E-02	1.098	0.3
.475	0.00	0.00	0.000E+00	7.00E-02	0.000	0.01	3.35E-04	0.07	4.90E-03	6.84E-02	0.543	0.1
.575	0.00	0.00	0.000E+00	3.00E-03	0.000	0.01	1.74E-05	0.025	7.50E-05	2.32E-01	0.807	0.2
.311	0.00	0.00	0.000E+00	3.00E-01	0.000	0.01	2.51E-02	1.0	3.00E-01	8.38E-02	8.394	2.3
4.117	0.00	0.00	0.000E+00	2.40E-02	0.000	0.01	3.42E-03	0.040	9.60E-04	3.56E+00	17.675	4.9
.065	5.56	11.37	6.106E-02	1.70E-03	35.915	2.10E-02	6.77E-05	1.0	3.00E-03	2.26E-02	37.003	10.
.054	3.77	2.62	1.408E-02	2.00E-02	0.704	4.10E-02	4.49E-05	1.0	2.00E-02	2.25E-03	0.760	0.2
.012	3.67	0.27	1.451E-03	9.00E-05	16.121	8.90E-03	1.03E-06	1.0	1.00E-02	1.03E-04	16.132	4.4
.057	2.80	0.92	4.920E-03	9.00E-03	0.547	8.70E-02	4.48E-05	1.0	9.00E-03	4.98E-03	0.608	0.1
.019	2.70	0.99	5.337E-03	2.30E-01	0.023	6.20E-02	3.60E-05	1.0	3.00E-02	1.20E-03	0.044	0.0
.052	26.10	7.79	4.185E-02	9.00E-03	4.649	1.60E-02	7.53E-06	1.0	9.00E-03	8.36E-04	4.702	1.3
.854	3.37	39.97	2.146E-01	1.00E-02	21.464	1.00E-02	1.87E-04	1.0	1.00E-02	1.87E-02	23.337	6.4
.086	6.72	7.42	3.985E-02	2.00E-02	1.992	1.00E-02	1.74E-05	1.0	2.00E-02	8.70E-04	2.080	0.5
.005	3.25	0.66	3.569E-03	8.60E-02	0.041	4.50E-03	1.45E-06	1.0	6.00E-02	2.42E-05	0.047	0.0
.131	0.48	0.81	4.349E-03	8.60E-04	5.057	6.90E-02	1.82E-04	1.0	2.00E-02	9.11E-03	5.197	1.4
.051	10.50	3.44	1.845E-02	1.00E-02	1.845	1.00E-03	5.16E-07	1.0	1.00E-02	5.16E-05	1.896	0.5
.996	17.70	679.04	3.646E+00	3.00E-02	121.546	4.80E-02	2.90E-03	1.0	1.00E-02	2.90E-01	127.832	35.
.451	10.00	94.07	5.051E-01	5.67E-03	89.090	1.60E-02	2.37E-04	1.0	6.00E-03	3.95E-02	91.580	25.
.017	6.16	3.28	1.759E-02	1.73E-03	10.166	1.00E-01	8.38E-05	1.0	5.00E-02	1.68E-03	10.185	2.8
.005	8.77	1.43	7.704E-03	1.73E-03	4.453	1.00E-01	2.58E-05	1.0	5.00E-02	5.16E-04	4.459	1.2
.831	56.00	89.33	4.797E-01	1.00E-01	4.797	7.30E-03	1.83E-05	1.0	3.00E-03	6.12E-03	5.634	1.5
.000	7.00	1.43	7.687E-03	2.00E+00	0.004	8.00E-02	2.58E-05	1.0	2.00E+00	1.29E-05	0.004	0.0
.000	7.00	0.86	4.612E-03	2.00E+00	0.002	8.00E-02	1.55E-05	1.0	2.00E+00	7.73E-06	0.002	0.0
										Hazard Index	**360.02**	

Noncarciongenic Risk for Groundwater Exposure - Arkwright Landfill, Spartanburg

Child (7-12) Noncarcinogenic Effects
Future Off-Site Resident

	MW	C_w µg/L	C_w mg/L	Intake mg/kg day	Ingestion RfD_o Ref. Dose mg/(kg day)	Hazard Quotient Intake/R_fD_o	Hazard HSDB H x (10^3) M^3-atm/mol	C_a mg/M^3	Intake mg/kg day	Inhalation RfD_i Ref. Dose mg/(kg day)	Ha Qu Intal
GROUNDWATER											
Arsenic	74.9	5.0	0.0050	3.55E-04	3.00E-04	1.184	0.00	0.00	0.000E+00	0.000	0.0
Barium	137.3	520	0.5200	3.69E-02	7.00E-02	0.528	0.00	0.00	0.000E+00	0.070	0.0
Chromium	52.0	27	0.0270	1.92E-03	3.00E-03	0.639	0.00	0.00	0.000E+00	0.003	0.0
Iron	55.8	39,000	39.0000	2.77E+00	3.00E-01	9.234	0.00	0.00	0.000E+00	0.300	0.0
Manganese	54.9	5,300	5.3000	3.76E-01	2.40E-02	15.686	0.00	0.00	0.000E+00	0.024	0.0
Benzene	78.1	50.00	0.0500	3.55E-03	3.00E-03	1.184	5.56	11.37	3.392E-02	1.70E-03	2.0
Chlorobenzene	112.6	17	0.0170	1.21E-03	0.02	0.060	3.77	2.62	7.820E-03	0.020	3.9
Chloroform	119.4	1.80	0.0018	1.28E-04	1.0E-02	0.013	3.67	0.27	8.060E-04	9.00E-05	8.9
1,3-Dichlorobenzene	147.0	8.00	0.0080	5.68E-04	9.0E-03	0.063	2.80	0.92	2.733E-03	0.009	3.0
1,4-Dichlorobenzene	147.0	9.0	0.0090	6.39E-04	3.0E-02	0.021	2.70	0.99	2.965E-03	0.230	1.2
1,1-Dichloroethene	96.9	7.30	0.0073	5.19E-04	9.0E-03	0.058	26.10	7.79	2.325E-02	0.009	2.5
cis-Dichloroethene	96.9	290.00	0.2900	2.06E-02	1.0E-02	2.060	3.37	39.97	1.192E-01	0.010	1.1
trans-Dichloroethene	96.9	27.00	0.0270	1.92E-03	2.0E-02	0.096	6.72	7.42	2.214E-02	0.020	1.1
Methylene chloride	84.9	5.0	0.0050	3.55E-04	6.0E-02	0.006	3.25	0.66	1.983E-03	0.860	2.3
Naphthalene	128.2	41.0	0.0410	2.91E-03	2.0E-02	0.146	0.48	0.81	2.416E-03	0.001	2.81
n-Propylbenzene	120.2	8.0	0.0080	5.68E-04	1.0E-02	0.057	10.50	3.44	1.025E-02	0.010	1.0
Tetrachloroethene	165.8	938	0.9380	6.66E-02	1.0E-02	6.663	17.70	679.04	2.026E+00	0.030	6.7
Trichloroethene	131.4	230	0.2300	1.63E-02	6.0E-03	2.723	10.00	94.07	2.806E-01	0.006	4.9
1,2,4-Trimethylbenzene	120.2	13	0.0130	9.23E-04	5.0E-02	0.018	6.16	3.28	9.771E-03	0.002	5.65
1,3,5-Trimethylbenzene	120.2	4	0.0040	2.84E-04	5.0E-02	0.006	8.77	1.43	4.280E-03	0.002	2.47
Vinyl Chloride	62.5	39	0.0390	2.77E-03	3.0E-03	0.923	56.00	89.33	2.665E-01	0.100	2.66
o-Xylene	106.2	5	0.0050	3.55E-04	2.0E+00	0.000	7.00	1.43	4.271E-03	2.000	2.1
p-Xylene	106.2	3	0.0030	2.13E-04	2.0E+00	0.000	7.00	0.86	2.562E-03	2.000	1.2

·e - Arkwright Landfill, Spartanburg, South Carolina

:) Noncarcinogenic Effects
re Off-Site Resident

Hazard HSDB $H \times (10^3)$ M^3-atm/mol	C_a mg/M^3	Intake mg/kg day	Inhalation RfD_i Ref. Dose mg/(kg day)	Hazard Quotient Intake/R_fD_i	Kp cm/hr	Intake mg/kg day	ABS	Absorption RfD_d Ref. Dose mg/(kg day)	Hazard Quotient Intake/R_fD_d	Total Hazard Quotient	% of Risk
0.00	0.00	0.000E+00	0.000	0.00E+00	3.00E-02	7.83E-06	1.0	3.00E-04	2.61E-02	1:210	0.55%
0.00	0.00	0.000E+00	0.070	0.00E+00	0.01	2.71E-04	0.07	4.90E-03	5.54E-02	0.583	0.26%
0.00	0.00	0.000E+00	0.003	0.00E+00	0.01	1.41E-05	0.025	7.50E-05	1.88E-01	0.827	0.37%
0.00	0.00	0.000E+00	0.300	0.00E+00	0.01	2.04E-02	1.0	3.00E-01	6.79E-02	9.302	4.19%
0.00	0.00	0.000E+00	0.024	0.00E+00	0.01	2.77E-03	0.04	9.60E-04	2.88E+00	18.568	8.37%
5.56	11.37	3.392E-02	1.70E-03	2.00E+01	2.10E-02	5.48E-05	1.0	3.00E-03	1.83E-02	21.155	9.54%
3.77	2.62	7.820E-03	0.020	3.91E-01	4.10E-02	3.64E-05	1.0	2.00E-02	1.82E-03	0.453	0.20%
3.67	0.27	8.060E-04	9.00E-05	8.96E+00	8.90E-03	8.36E-07	1.0	1.00E-02	8.36E-05	8.969	4.04%
2.80	0.92	2.733E-03	0.009	3.04E-01	8.70E-02	3.63E-05	1.0	9.00E-03	4.04E-03	0.371	0.17%
2.70	0.99	2.965E-03	0.230	1.29E-02	6.20E-02	2.91E-05	1.0	3.00E-02	9.71E-04	0.035	0.02%
26.10	7.79	2.325E-02	0.009	2.58E+00	1.60E-02	6.10E-06	1.0	9.00E-03	6.78E-04	2.641	1.19%
3.37	39.97	1.192E-01	0.010	1.19E+01	1.00E-02	1.51E-04	1.0	1.00E-02	1.51E-02	13.999	6.31%
6.72	7.42	2.214E-02	0.020	1.11E+00	1.00E-02	1.41E-05	1.0	2.00E-02	7.05E-04	1.204	0.54%
3.25	0.66	1.983E-03	0.860	2.31E-03	4.50E-03	1.17E-06	1.0	6.00E-02	1.96E-05	0.008	0.00%
0.48	0.81	2.416E-03	0.001	2.81E+00	6.90E-02	1.48E-04	1.0	2.00E-02	7.38E-03	2.963	1.34%
10.50	3.44	1.025E-02	0.010	1.02E+00	1.00E-03	4.18E-07	1.0	1.00E-02	4.18E-05	1.082	0.49%
17.70	679.04	2.026E+00	0.030	6.75E+01	4.80E-02	2.35E-03	1.0	1.00E-02	2.35E-01	74.423	33.56%
10.00	94.07	2.806E-01	0.006	4.95E+01	1.60E-02	1.92E-04	1.0	6.00E-03	3.20E-02	52.249	23.56%
6.16	3.28	9.771E-03	0.002	5.65E+00	1.00E-01	6.79E-05	1.0	5.00E-02	1.36E-03	5.668	2.56%
8.77	1.43	4.280E-03	0.002	2.47E+00	1.00E-01	2.09E-05	1.0	5.00E-02	4.18E-04	2.480	1.12%
56.00	89.33	2.665E-01	0.100	2.66E+00	7.30E-03	1.49E-05	1.0	3.00E-03	4.95E-03	3.593	1.62%
7.00	1.43	4.271E-03	2.000	2.14E-03	8.00E-02	2.09E-05	1.0	2.00E+00	1.04E-05	0.002	0.00%
7.00	0.86	2.562E-03	2.000	1.28E-03	8.00E-02	1.25E-05	1.0	2.00E+00	6.26E-06	0.001	0.00%
									Hazard Index	221.79	

Noncarciongenic Risk for Groundwater Exposure - Arkwright Landfill, Spart

Adult Noncarcinogenic Effects
Future Off-Site Resident

							Ingestion RfD_o Ref. Dose	Hazard Quotient	Hazard HSDB H x (10^1)			Inhalati RfD_i Ref Dos
			MW	C_w µg/L	C_w mg/L	Intake mg/kg day	mg/(kg day)	Intake/R_fD_o	M^3-atm/mol	C_s mg/M^3	Intake mg/kg day	mg/(kg da
		GROUNDWATER										
	L/day	Arsenic	74.9	5.0	0.0050	1.37E-04	3.00E-04	0 457	0.00	0.00	0.000E+00	3.00E-0
	M^3 of air/day	Barium	137.3	520	0.5200	1 42E-02	7.00E-02	0.204	0.00	0.00	0.000E+00	7 00E-0
;	hr/day	Chromium	52.0	27	0.0270	7.40E-04	3.00E-03	0.247	0.00	0.00	0.000E+00	3.00E-0
)0	cm^2	Iron	55.8	39,000	39.0000	1.07E+00	3.00E-01	3.562	0.00	0.00	0 000E+00	3 00E-0
	days/year	Manganese	54.9	5,300	5.3000	1.45E-01	2.40E-02	6.050	0.00	0.00	0.000E+00	2.40E-0
	years	Benzene	78.1	50.00	0.0500	1.37E-03	3.00E-03	0.457	5 56	11.37	2.336E-02	1.70E-0
	kg	Chlorobenzene	112.6	17	0.0170	4.66E-04	0.02	0.023	3 77	2.62	5.386E-03	2.00E-0
·0	days (carcin)	Chloroform	119.4	1 80	0.0018	4.93E-05	1.0E-02	0.005	3.67	0.27	5.552E-04	9.00E-0
		1,3-Dichlorobenzene	147.0	8.00	0.0080	2.19E-04	9.0E-03	0.024	2.80	0.92	1.883E-03	9 00E-0
		1,4-Dichlorobenzene	147.0	9.0	0.0090	2.47E-04	3.0E-02	0.008	2.70	0.99	2.042E-03	2.30E-0
		1,1-Dichloroethene	96.9	7.30	0.0073	2.00E-04	9.0E-03	0.022	26.10	7.79	1.601E-02	9.00E-0
		cis-Dichloroethene	96.9	290.00	0.2900	7.95E-03	1.0E-02	0.795	3.37	39.97	8.213E-02	1.00E-0
		trans-Dichloroethene	96.9	27.00	0.0270	7.40E-04	2.0E-02	0.037	6.72	7.42	1.525E-02	2.00E-0
		Methylene chloride	84.9	5.0	0.0050	1.37E-04	6.0E-02	0.002	3.25	0.66	1.366E-03	8 60E-0
		Naphthalene	128.2	41.0	0.0410	1.12E-03	2.0E-02	0.056	0.48	0.81	1.664E-03	8.60E-0
		n-Propylbenzene	120.2	8.0	0.0080	2.19E-04	1.0E-02	0 022	10.50	3.44	7.059E-03	1.00E-0
		Tetrachloroethene	165.8	938	0.9380	2.57E-02	1.0E-02	2.570	17.70	679.04	1.395E+00	3.00E-0
		Trichloroethene	131.4	230	0.2300	6.30E-03	6 0E-03	1.050	10.00	94.07	1.933E-01	5 67E-0
		1,2,4-Trimethylbenzene	120.2	13	0.0130	3.56E-04	5.0E-02	0.007	6.16	3.28	6.730E-03	1.73E-0
		1,3,5-Trimethylbenzene	120.2	4	0.0040	1.10E-04	5.0E-02	0.002	8.77	1.43	2 948E-03	1.73E-0
		Vinyl Chloride	62.5	39	0.0390	1.07E-03	3.0E-03	0.356	56.00	89.33	1.835E-01	1.00E-01
		o-Xylene	106.2	5	0.0050	1.37E-04	2.0E+00	0.000	7.00	1 43	2 941E-03	2.00E+0
		p-Xylene	106.2	3	0.0030	8.22E-05	2 0E+00	0.000	7.00	0.86	1.765E-03	2.00E+0

er Exposure - Arkwright Landfill, Spartanburg, South Carolina

Adult Noncarcinogenic Effects
Future Off-Site Resident

Hazard Quotient Intake/R_fD_o	Hazard HSDB H x (10^3) M^3-atm/mol	C_a mg/M^3	Intake mg/kg day	Inhalation RfD_i Ref. Dose mg/(kg day)	Hazard Quotient Intake/R_fD_o	Kp cm/hr	Intake mg/kg day	ABS ABS	Absorption RfD_d Ref. Dose mg/(kg day)	Hazard Quotient Intake/R_fD_o	Total Hazard Quotient	% Ri
0.457	0.00	0.00	0.000E+00	3 00E-04	0.000	3.00E-02	9.35E-06	1 0	3.00E-04	3 12E-02	0.488	0.3
0.204	0.00	0.00	0 000E+00	7 00E-02	0.000	0.01	3.24E-04	0.07	4.90E-03	6.61E-02	0.270	0.1
0 247	0.00	0.00	0.000E+00	3.00E-03	0.000	0.01	1.68E-05	0.025	7.50E-05	2.24E-01	0.471	0.3
3 562	0.00	0 00	0.000E+00	3.00E-01	0.000	0 01	2.43E-02	1.0	3 00E-01	8 10E-02	3 643	2.5
6.050	0.00	0.00	0.000E+00	2.40E-02	0.000	0 01	3.30E-03	0.04	9 60E-04	3.44E+00	9 491	6.6
0.457	5 56	11.37	2.336E-02	1.70E-03	13.743	2.10E-02	6.54E-05	1.0	3.00E-03	2.18E-02	14.222	10.0
0.023	3.77	2.62	5.386E-03	2.00E-02	0.269	4 10E-02	4.34E-05	1 0	2.00E-02	2.17E-03	0.295	0.21
0.005	3.67	0.27	5.552E-04	9.00E-05	6.169	8.90E-03	9.99E-07	1.0	1.00E-02	9.99E-05	6.174	4.3
0.024	2 80	0.92	1.883E-03	9 00E-03	0 209	8.70E-02	4.34E-05	1.0	9.00E-03	4.82E-03	0.238	0.1
0.008	2.70	0.99	2.042E-03	2.30E-01	0.009	6.20E-02	3.48E-05	1.0	3.00E-02	1 16E-03	0 018	0 01
0 022	26.10	7.79	1 601E-02	9.00E-03	1.779	1.60E-02	7.28E-06	1.0	9 00E-03	8 09E-04	1.802	1.27
0.795	3.37	39.97	8.213E-02	1.00E-02	8.213	1.00E-02	1.81E-04	1.0	1 00E-02	1 81E-02	9.026	6 35
0.037	6.72	7.42	1.525E-02	2.00E-02	0 762	1.00E-02	1.68E-05	1.0	2 00E-02	8.41E-04	0 800	0.56
0.002	3 25	0.66	1.366E-03	8.60E-02	0.016	4 50E-03	1 40E-06	1.0	6.00E-02	2.34E-05	0 018	0.01
0.056	0.48	0 81	1.664E-03	8.60E-04	1.935	6.90E-02	1.76E-04	1 0	2.00E-02	8.82E-03	2.000	1.41
0 022	10.50	3.44	7.059E-03	1.00E-02	0.706	1.00E-03	4.99E-07	1.0	1 00E-02	4.99E-05	0.728	0.51
2.570	17.70	679.04	1.395E+00	3.00E-02	46.510	4.80E-02	2.81E-03	1 0	1.00E-02	2.81E-01	49 360	34.7
1.050	10.00	94.07	1.933E-01	5.67E-03	34.091	1.60E-02	2.29E-04	1.0	6.00E-03	3.82E-02	35.179	24.7
0.007	6.16	3.28	6.730E-03	1.73E-03	3.890	1.00E-01	8.10E-05	1.0	5.00E-02	1 62E-03	3.899	2.75
0.002	8 77	1.43	2.948E-03	1.73E-03	1.704	1.00E-01	2.49E-05	1 0	5.00E-02	4 99E-04	1.707	1.20
0 356	56 00	89.33	1.835E-01	1.00E-01	1.835	7.30E-03	1.77E-05	1 0	3.00E-03	5 92E-03	2.198	1.55
0.000	7.00	1.43	2.941E-03	2.00E+00	0.001	8.00E-02	2 49E-05	1 0	2 00E+00	1.25E-05	0.002	0.00
0 000	7 00	0.86	1.765E-03	2.00E+00	0.001	8.00E-02	1.50E-05	1.0	2 00E+00	7.48E-06	0.001	0.00

Hazard Index **142.03**

Carcinogenic for Groundwater Exposure - Arkwright Landfill, Spartanburg, Soutl

Lifetime
Future Off Site Resident

	MW	C_w µg/L	C_w mg/L	Ingestion Intake mg/kg day	SF_o Slope Factor (kg day)/mg	Risk SF_o * Intake	HSDB H x (10^3) M^3-atm/mol	Inhalation Risk SF_o * Intak
GROUNDWATER								
Arsenic	74.9	5.0	0.0050	5.87E-05	1.5E+00	8.806E-05		
Benzene	78.1	50.00	0.0500	5.87E-04	5.5E-02	3.229E-05	5.56	2.73E-04
Chloroform	119.4	1.80	0.0018	2.11E-05	6.1E-03	1.289E-07	3.67	1.93E-05
1,4-Dichlorobenzene	147.0	9.0	0.0090	1.06E-04	2.4E-02	2.536E-06	2.70	2.10E-05
1,1-Dichloroethene	96.9	7.30	0.0073	8.57E-05	6.0E-01	5.143E-05	26.10	1.24E-03
Methylene chloride	84.9	5.0	0.0050	5.87E-05	7.5E-03	4.403E-07	3.25	9.36E-07
Tetrachloroethene	165.8	938	0.9380	1.10E-02	5.2E-02	5.727E-04	17.70	1.20E-03
Trichloroethene	131.4	230	0.2300	2.70E-03	1.1E-02	2.971E-05	10.00	4.97E-04
Vinyl Chloride	62.5	39	0.0390	4.58E-04	1.5E+00	6.869E-04	56.00	2.44E-03
2,3,7,8-TCDD Equivalents	390.9	7.40E-07	7.40E-10	8.69E-12	1.5E+05	1.303E-06	6.700E-03	2.68E-08
alpha-BHC (α-HCH)	290.8	0.17	0.0002	2.00E-06	6.3E+00	1.258E-05	6.900E-04	2.66E-08
beta-BHC (β-HCH)	290.8	0.83	0.0008	9.75E-06	1.8E+00	1.754E-05	3.900E-03	2.10E-07
Arochlor 1242	261.0	1.45	0.0015	1.70E-05	4.0E-01	6.810E-06	3.900E-03	8.15E-08

osure - Arkwright Landfill, Spartanburg, South Carolina

Lifetime
Future Off Site Resident

	Ingestion		Inhalation				Absorption		
	SF_o		HSDB				SF_d		
	Slope Factor	Risk	H x (10^3)	Risk	Kp	Intake	Slope Factor	Risk	Total
ay	(kg day)/mg	SF_o * Intake	M^3-atm/mol	SF_o * Intake	cm/hr	mg/kg day	(kg day)/mg	SF_o * Intake	Risk
5	1.5E+00	8.806E-05			3.00E-02	1.14E-08	1.50E+00	1.72E-08	8.81E-05
4	5.5E-02	3.229E-05	5.56	2.73E-04	2.10E-02	8.01E-08	5.50E-02	4.41E-09	3.06E-04
5	6.1E-03	1.289E-07	3.67	1.93E-05	8.90E-03	1.22E-09	6.10E-03	7.46E-12	1.94E-05
4	2.4E-02	2.536E-06	2.70	2.10E-05	6.20E-02	4.26E-08	2.40E-02	1.02E-09	2.35E-05
5	6.0E-01	5.143E-05	26.10	1.24E-03	1.60E-02	8.91E-09	6.00E-01	5.35E-09	1.29E-03
5	7.5E-03	4.403E-07	3.25	9.36E-07	4.50E-03	1.72E-09	7.50E-03	1.29E-11	1.38E-06
2	5.2E-02	5.727E-04	17.70	1.20E-03	4.80E-02	1.20E-03	5.20E-02	6.25E-05	1.83E-03
3	1.1E-02	2.971E-05	10.00	4.97E-04	1.60E-02	2.81E-07	1.10E-02	3.09E-09	5.27E-04
4	1.5E+00	6.869E-04	56.00	2.44E-03	7.30E-03	2.17E-08	1.50E+00	3.26E-08	3.13E-03
2	1.5E+05	1.303E-06	6.700E-03	2.68E-08	3.00E-02	1.69E-15	1.50E+05	2.54E-10	1.33E-06
6	6.3E+00	1.258E-05	6.900E-04	2.66E-08	5.00E-02	6.49E-10	6.30E+00	4.09E-09	1.26E-05
6	1.8E+00	1.754E-05	3.900E-03	2.10E-07	5.00E-02	3.17E-09	1.80E+00	5.70E-09	1.78E-05
5	4.0E-01	6.810E-06	3.900E-03	8.15E-08	5.00E-02	5.53E-09	1.50E+00	8.30E-09	6.90E-06
								Total Risk	**7.25E-03**

APPENDIX C
STATE CONCURRENCE LETTER

D H E C

PROMOTE PROTECT PROSPER

2600 Bull Street
Columbia, SC 29201-1708

U.S. EPA REGION 4
OFFICE OF
REGIONAL ADMINISTRATOR

2002 SEP 30 P 1:59

September 30, 2002

Jimmy Palmer
Regional Administrator
U.S. EPA, Region IV
Atlanta Federal Center
61 Forsyth Street, SW
Atlanta, Georgia 30303

Re : Arkwright Landfill Site
Spartanburg, South Carolina
Final Record of Decision

Dear Mr. Palmer :

The Department has reviewed and concurs with all parts of the Record of Decision (ROD) dated September 2002 for the Arkwright Landfill Site located in Spartanburg, South Carolina. In concurring with this ROD, the South Carolina Department of Health and Environmental Control (SCDHEC) does not waive any right or authority it may have under federal or state law. SCDHEC reserves any right or authority it may have to require corrective action in accordance with the South Carolina Pollution Control Act. These rights include, but are not limited to, the right to insure that all necessary permits are obtained, all clean-up goals and remedial criteria are met, and to take separate action in the event clean-up goals and remedial criteria are not met. Nothing in the concurrence shall preclude SCDHEC from exercising any additional administrative, legal, and equitable remedies available to the Department that require additional response actions in the event that: (1)(a) previously unknown or undetected conditions arise at the site or (b) SCDHEC receives information not previously available concerning the premises upon which SCDHEC relied in concurring with the selected alternative; and (2) the implementation of the remedial alternative selected in the ROD is no longer protective human health or the environment.

The Department has reviewed and issued an approval to USEPA on all documents used in evaluating the site except the Baseline Risk Assessment (BRA). As of the date of this letter, we have not received a BRA sufficient to approve based on an evaluation of Risk Assessment Guidance for Superfund (RAGS), EPA Region IV Supplemental Guidance to RAGS and the EPA Draft Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk

Assessments. However, because the Department believes an accurate and complete remedial evaluation can be made for the site without the approved BRA using ARARs and Presumptive Remedy Guidance, we are proceeding with the concurrence process.

The Department concurs with the four major components of the Selected Remedy as described in the ROD. We concur that Institutional Controls, including a restrictive covenant, will be employed at the site to prevent future exposure to soil contaminants and underlying landfill material. We concur with the use of the Presumptive Remedy component that consists of the construction of a flexible membrane liner (FML) cap over the existing landfill material. This concurrence is predicated on the fact that the FML cap will be constructed and monitored in accordance to ARARs for solid waste landfills.

The Department concurs with the remedy components for groundwater that include implementation of an enhanced biodegradation process and long-term monitoring. According to the ROD, a pilot scale study(s) will be conducted during the Remedial Design to determine delivery strategies, target treatment areas, and possible treatment solutions/reagents for the enhanced biodegradation process. The Department understands that the timing of the final groundwater remediation process may depend on the successful construction of the FML cap. Finally, this concurrence requires that a long-term groundwater monitoring network and sampling plan will be submitted for Department approval during the Remedial Design.

If you should have any questions regarding the Department's concurrence with the ROD, please contact Scott Wilson at (803) 896-4077.

Sincerely,

R. Lewis Shaw

R. Lewis Shaw
Deputy Commissioner
Environmental Quality Control

cc : Hartsill Truesdale, BLWM
Keith Lindler, BLWM
Richard Haynes, BLWM
Scott Wilson, BLWM
Kent Coleman, BLWM
Cindy Carter, APPIII
54475; file

APPENDIX D
SELECTED REMEDY COST SUMMARY

APPENDIX D
Selected Remedy Cost Summary

Soil Component (Presumptive Remedy) - Capping								
Item	**Item Description**	**Unit**	**Unit Cost $**	**Basis or Qualification**	**Qty**	**Basis of Quantity**	**Item Cost**	**Total Cost**
Direct Capital Costs								
1.00	Mobilization	LS	32,000	1% of direct capital costs; H&S, office, phone, water, Porta-Johns, etc.	1	Contractor experience	32,000	32,000
							Total Mobilization	32,000
2.00	Site Work							
2.10	Cut access roads	LF	5.00	Grade, minimal stone, extent of fill area	4500	Around perimeter	22,500	
2.20	Clear site, grub & chip	AC	2800	Means Cost Est Guide	28	Entire area	78,400	
							Total Site Work	101,000
3.00	Excavate and Haul Trash							
3.10	Offsite mound removal	CY	10.00	Contractor experience	12,000	CADD volume	120,000	
3.20	Move waste to stabilize slopes	CY	10.00	Contractor experience	47,000	CADD volume	470,000	
3.30	Remove waste in corridor	CY	10.00	Contractor experience	9600	CADD volume	96,000	
							Total Excavate and Haul Trash	686,000

APPENDIX D
Selected Remedy Cost Summary (cont'd)

Soil Component (Presumptive Remedy) - Capping (continued)

Item	Item Description	Unit	Unit Cost $	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
4.00	Install Cap							
4.10	Install synthetic liner	SF	0.45	Means CE Guide	1.09 million	Calc; 2 separate capped areas	490,506	
4.17	Purchase of Cover Material	CY	3.20	Purchase price	121,113	25 AC, 24-inch soil plus 6-in. for topsoil	387,562	
4.19	Load, haul, dump, grade. compact	CY	9.30	$8.00 to cut and haul	80,742	Soil cover only	750,899	
4.22	Manufacture topsoil	CY	3.00	Contractor experience	40,371	12 in. over the Site	121,113	
4.23	Load, haul, dump, grade. compact	CY	8.20	Contractor previous job	40,371	12 in. over the Site	331,041	
4.25	Grade and Hydro-seed	AC	3494	Means CE Guide	30	Site is 30 acres	104,820	
4.29	Construct diversion ditches	LF	12.32	Means CE Guide	1,569	Calc/Site drawings	19,330	
							Total Install Cap	2,205,000
5.00	Install Down Drains, Paved Ditches							
5.10	Fine grade, install geotextile	SY	2.82	Means CE Guide	1651	Calc, hand-work, partial rolls	4,655	

APPENDIX D
Selected Remedy Cost Summary (cont'd)

Soil Component (Presumptive Remedy) - Capping (continued)

Item	Item Description	Unit	Unit Cost $	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
Soil Component (Presumptive Remedy) - Capping (continued)								
5.12	Install Rip-Rap	LF	18.08	Means CE Guide	1486	Calc/Site drawings	26,858	
	Total Install Down Drains, Paved Ditches							32,000
6.00	Passive Gas Collection							
6.10	Trenching and Backfill	LF	9.00	Includes sand backfill (Means)	3561	Calc - perimeter@top of 3to1, plus top area	32,049	
6.12	Collection piping	LF	11.99	6-in. perforated HDPE	3561	(same as 6.10)	42,696	
6.14	Dispersion stacks	EA	190.10	10 ft high	18	Calc - every 200 ft	3,422	
	Total Passive Gas Collection							78,000
7.00	Soil & Erosion Control							
7.10	Silt fencing	LF	5.89	Means CE Guide	4000	Calc	23,560	
7.20	Construct mud pad	EA	450	Contractor experience	3	Assume replace 3x	1,350	
	Total Soil & Erosion Control							25,000
8.00	Public Road Repair							
	Public Road Repair	SY	5.50	Means CE Guide	6667	Calc - 3333 LF of road	36,667	

APPENDIX D
Selected Remedy Cost Summary (cont'd)

Soil Component (Presumptive Remedy) - Capping (continued)

Item	Item Description	Unit	Unit Cost $	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
							Total Public Road Repair	37,000
9.00	Site Fencing							
	Site Fencing		17	Means CE Guide	4261	CADD computed	72,437	
							Total Site Fencing	72,000
				Subtotal Direct Capital Costs				3,268,000
Indirect Capital Costs								
11.00	Engineering Services							
11.10	Design	LS		5% of direct capital costs	1	(5% of 3,268,000)	163,400	
11.11	Work Plan, Project Manual	LS	15,000	Contractor experience	1		15,000	
11.12	Contract Management	LS	32,680	1% of direct capital costs	1		32,680	
11.13	Project Management	HR	80	Field Rate	100	Contractor estimate	8,000	
11.14	Construction Oversight	HR	65	Field rate, car, perdiem	2080	52 wks x 40 hrs/wk	135,200	
							Total Engineering Services	354,000
12.00	Other Services							
12.10	Permitting and Legal Costs	LS	25,000	Contractor estimate/experience	1		25,000	
12.11	Final Report Writing	HR	85	Average Professional Rate	60	Contractor estimate	5,100	

APPENDIX D
Selected Remedy Cost Summary (cont'd)

Soil Component (Presumptive Remedy) - Capping (continued)

Item	Item Description	Unit	Unit Cost $	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
	Total Other Services							30,000
	Subtotal Indirect Capital Costs							384,000
	Subtotal Indirect Capital Costs							384,000
	Subtotal Direct Capital Costs (from above)							3,268,000
	Contingency (25% of direct capital costs)							913,000
	TOTAL CAPITAL COSTS - CAPPING							$ 4,565,000
Annual Operations and Maintenance (O&M) Costs								
20.00	Operations and Mainten.							
20.12	Gas Collection- Monitoring Maintenance and Operation	YR	2,000	Contractor estimate	1		2,000	
20.15	Cap maintenance	AC	1,000	Contractor estimate	27	Cap area + perimeter	27,000	
20.18	Administration and Reporting	YR	15,000	Contractor estimate	1		15,000	
20.19	Contingency	LS	11,000	25% of O&M cost	1		11,000	
	Total Annual O&M							55,000
	TOTAL PRESENT WORTH VALUE, 30 years O&M Costs (55,000) at 7% discount rate							675,000
	TOTAL PRESENT WORTH VALUE, PRESUMPTIVE REMEDY (CAPPING)							**$5,240,000**

TABLE L-1
Selected Remedy Cost Summary (cont'd)

Groundwater Component - Enhanced Biodegradation

Item	Item Description	Unit	Unit Cost $	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
Direct Capital Costs								
1.00	Install Monitoring Well							
1.10	Driller Mobilization	LS	500	Contractor experience	1		500	
1.11	Installation of Well	FT	65	Contractor experience	60	60 ft well, 6-in. casing, 2-in. PVC well	3,900	
	Total Install Monitoring Well							4,400
2.00	Application of HRC							
2.10	Mobilize/demobilize	LS	1,000	Contractor experience	1	108 points @ 20 ft; 177 points @ 10 ft	1,000	
2.11	Purchase of HRC	LB	6.00	Bid price received	8,000	4,000 ft of injection, 2lbs/ft	48,000	
2.12	Geoprobe for Injection	DAY	1,500	Contractor experience	12	Avg of 25/day installed	18,000	
2.13	Preparation, Contracting, Summary Report	LS	15,000	Contractor experience	1		15,000	
2.14	Construction Documentation	DAY	1,000	10 hrs/day @ $85.00/hr plus perdiem	12	Initial application	12,000	
2.15	Permitting, Regulatory Assistance	LS	5,000	Contractor experience	1		5,000	

APPENDIX D
Selected Remedy Cost Summary (cont'd)

Groundwater Component - Enhanced Biodegradation (cont'd)

Item	Item Description	Unit	Unit Cost $	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
	Total Application of HRC (Initial Event)							98,000
3.00	Treatability Study							
3.10	Prepare Work Plan	LS	5,000	Similar site experience-Contractor	1		5,000	
3.20	Install Observation Points	LS	10,000	Similar site experience-Contractor	1		10,000	
3.30	Inject Amendment	LS	25,000	Similar site experience-Contractor	1		25,000	
3.40	Sampling and Analysis	LS	15,000	Similar site experience-Contractor	1		15,000	
3.50	Treatability Study Report	LS	10,000	Similar site experience-Contractor	1		10,000	
	Total Treatability Study							65,000
Subtotal Direct Capital Costs								167,000
Indirect Capital Costs								
4.00	Engineering Services							
6.10	Preparation and Oversight	HR	90	Field Rate-Contractor experience	40	Oversee well installation	3,600	
6.20	Prepare CERCLA Design	LS	75,000	Contractor experience-similar sites	1		75,000	
6.30	Legal Services	LS	5,000	Estimate for deed restriction (if necessary)	1		5,000	
	Total Engineering Services							83,600

APPENDIX D
Selected Remedy Cost Summary (cont'd)

Groundwater Component - Enhanced Biodegradation (cont'd)

Item	Item Description	Unit	Unit Cost $	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
				Subtotal Indirect Capital Costs				83,600
				Subtotal Indirect Capital Costs Subtotal Direct Capital Costs (from above) Contingency (25% of direct capital costs) TOTAL CAPITAL COSTS - GROUNDWATER				83,600 167,000 37,590 $ 288,190
Annual Operations and Maintenance (O&M) Costs								
7.00	Operations and Maint.							
7.10	Maintain Monitor Wells	YR	3,000	Contractor experience-similar sites	1		3,000	
7.20	Groundwater Monitoring - Analytical Costs	EA	120	VOC analysis per sample	46	Semiannual, 16 wells + 1 blk + 6 surf water loc's, 3 days per event	5,520	
7.30	Groundwater Monitoring, Labor and Expenses	DAY	1,700	Two persons 10 hrs	3	Three days per event	5,100	
7.40	Administration and Reporting	YR	20,000	Contractor estimate	1		20,000	
7.50	Contingency	LS	8,405	15% of O&M Cost	1		8,405	
	Total Annual Operations and Maintenance							42,025

APPENDIX D
Selected Remedy Cost Summary (cont'd)

Groundwater Component - Enhanced Biodegradation (cont'd)	
Total Annual Operations and Maintenance	42,025
TOTAL PRESENT WORTH VALUE, 30 years O&M Costs (42,025) at 7% discount rate	516,000
TOTAL CAPITAL COSTS - GROUNDWATER	$ 288,190
TOTAL PRESENT WORTH VALUE, ENHANCED BIODEGRADATION	**$ 804,000**
PRESENT WORTH, PRESUMPTIVE REMEDY (CAPPING)	**$5,240,000**
PRESENT WORTH, ENHANCED BIODEGRADATION	**804,000**
SELECTED REMEDY TOTAL	**$ 6,044,000**

BLANK PAGE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4

RECORD OF DECISION
INTERNATIONAL MINERAL AND CHEMICAL CORPORATION (IMC)
FERTILIZER SUPERFUND SITE
SPARTANBURG, SOUTH CAROLINA

AUGUST 2014

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF CONTENTS

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

AOC	Administrative Order on Consent
ARARs	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CIP	Community Involvement Plan
COC	Contaminants of Concern
COPC	Contaminants of Potential Concern
DNT	Dinitrotoluene
EJ	Environmental Justice
EPA	U.S. Environmental Protection Agency
ESI	Expanded Site Inspection
FFS	Focused Feasibility Study
FS	Feasibility Study
HI	Hazard Index
HRS	Hazard Ranking System
HQ	Hazard Quotient
IEUBK	Integrated Exposure Uptake Biokinetic Model
IC	Institutional Control
IMC	International Mineral and Chemical Corporation
Mg/kg	Milligrams per kilogram
kg	Kilogram
MCL	Maximum Contaminant Level
μg/l	Microgram per liter
MNA	Monitored Natural Attenuation
MW	Monitoring Well
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
PSA	Preliminary Site Assessment
PRP	Potentially Responsible Party
RAA	Removal Action Areas
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
RfD	Reference Dose
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
RME	Reasonable Maximum Exposure
SARA	Superfund Amendments and Reauthorization Act

ABBREVIATIONS AND ACRONYMS

SCDHEC	South Carolina Department of Health and Environmental Control
SDWA	Safe Drinking Water Act
SI	Site Inspection
SLERA	Screening Level Ecological Risk Assessment
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Soil Screening Level
SVOC	Semi-volatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
TAP	Technical Assistance Program
TCLP	Toxicity Characteristic Leaching Procedure
USC	United States Code
VOCs	Volatile Organic Compounds

PART 1: THE DECLARATION

1.1 Site Name and Location

The International Mineral and Chemical Corporation (IMC) Superfund Site is located on 40.83 acres in the Arkwright community, south of the city of Spartanburg, Spartanburg County, South Carolina. The National Superfund Database Identification Number is SCD003350493.

1.2 Statement of Basis and Purpose

This decision document selects the remedial action for the International Mineral and Chemical Corporation Superfund Site (IMC Site, the Site). The remedy was selected in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), 42 United States Code (USC) §9601 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300, as amended. The remedial action selected is Alternative 2 – Infiltration Galleries. This remedy is described in detail in Section 12.0 (Selected Remedy) of this Record of Decision (ROD).

This decision is based on the Administrative Record for the IMC Site, which has been developed in accordance with Section 113(k) of CERCLA, 42 USC§9613(k). This Administrative Record is available for review at the Spartanburg County Library in Spartanburg, South Carolina, and at the United States Environmental Protection Agency (EPA) Region 4 Records Center in Atlanta, Georgia. The Administrative Record Index (Appendix D) identifies each of the items comprising the Administrative Record upon which the selection of the remedial action is based. The State of South Carolina, acting through the Department of Health and Environmental Control (SCDHEC) concurs with the selected remedy.

1.3 Assessment of the Site

The remedial action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants or contaminants into the environment.

1.4 Description of the Selected Remedy

The selected remedy for the IMC Site is Alternative 2, which is estimated to cost $2,190,000. The components of the remedy are described in detail in Section 12.0 (Selected Remedy) of this ROD. The major components of this alternative are:

- Infiltration galleries in and downgradient of the former sulfuric acid area to address the low pH soil and groundwater.

- Periodic application of a neutralizing solution

- Periodic sampling and analysis of monitoring wells.

- Institutional controls for site-wide groundwater use restrictions.

1.5 Statutory Determinations

The selected remedy will achieve the requirements of CERCLA §121, and the regulatory requirements of the NCP. This remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

The selected remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduce the toxicity, mobility, or volume of hazardous substances through treatment). The low pH soil and the contaminated groundwater will be treated in-situ using a neutralization chemical.

Restrictions on the use of groundwater are necessary to ensure protectiveness in the short term because the selected remedy will not immediately reduce contaminant levels in groundwater to levels that allow for unlimited use and unrestricted exposure.
Until groundwater contaminants are below cleanup levels and the Site is available for unlimited use and unrestricted exposure, EPA will perform five year reviews to ensure the protectiveness of human health and the environment. A policy review will be conducted within five years after the completion of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary (Part II) of this ROD. Additional information can be found in the Administrative Record file for this Site:

- Chemicals of concern and their respective concentrations – Section 7

- Baseline risk represented by the chemicals of concern – Section 7

- Remediation levels (i.e. cleanup levels) established for the chemicals of concern and the basis for these goals – Section 12

- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and this ROD – Section 7

- Estimated capital, annual operation and maintenance, and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected – Section 12

- Potential land and groundwater use that will be available at the Site as a result of the Selected Remedy – Section 12

- Key factor(s) that led to selecting the remedy – Section 12

1.7 Authorizing Signature

This ROD documents the selected remedy for contamination at the IMC Site. This remedy was selected by the EPA with the concurrence of SC DHEC (Appendix A). The Director of the Superfund Division (EPA, Region 4) has been delegated the authority to approve and sign this ROD.

U.S. Environmental Protection Agency (Region 4)

By: Date: 8/25/14
Randall Chaffins, Acting Director
Superfund Division

PART 2: THE DECISION SUMMARY

This Decision Summary provides a description of the Site-specific factors and analyses that led to the selection of the remedy for the Site. It includes background information about the Site, the nature and extent of contamination found at the Site, the assessment of human health and environmental risks posed by the contaminants at the Site, a description of previous cleanup activities, and the identification and evaluation of remedial action alternatives for the Site.

1.0 SITE NAME, LOCATION, AND DESCRIPTION

The IMC Site is an approximately 41-acre site located in the Arkwright community just south of Spartanburg, South Carolina (**Figure 1**). The facility was operated from about 1910 until closure in 1987 for nitrogen-phosphorus-potassium fertilizer production. The coordinates of the center of the site are 34°55'12" North latitude and 81°55'30" West longitude [U.S. Geological Survey (USGS, 1980)].

The Superfund Enterprise Management System (SEMS) Identification Number is SCD003350493. The lead agency for the IMC Site is the EPA. The SC DHEC is the support agency.

The Site is located on 40.83 acres. The facility is generally bounded on the north by undeveloped property and portions of Fairforest Creek, on the east by Fairforest Creek, to the south by the Arkwright Dump, a Superfund site and a few residential properties, and on the west by Seaboard Coast rail line. Other industrial properties in the vicinity of the Site include a Mt. Vernon Mills facility to the immediate northwest, an active Rhodia Chemical Company facility to the immediate southwest, and the inactive Arkwright Mills property to the north-northwest. Locations of these facilities are shown on **Figure 2**. The land uses in the vicinity of the Site include industrial, residential, and undeveloped properties.

The Site is characterized by 90 feet of relief. The portions of the property at the North Street Extension entrance are typified by ground surface elevations of approximately 700 feet above mean sea level (msl). However, much of the property adjacent to Fairforest Creek is no more than about 625 feet above msl. The elevation of Fairforest Creek east of the Site is about 610 feet above msl. Portions of the Site are within the 100 year-floodplain of Fairforest Creek.

Figure 1
Site Location Map

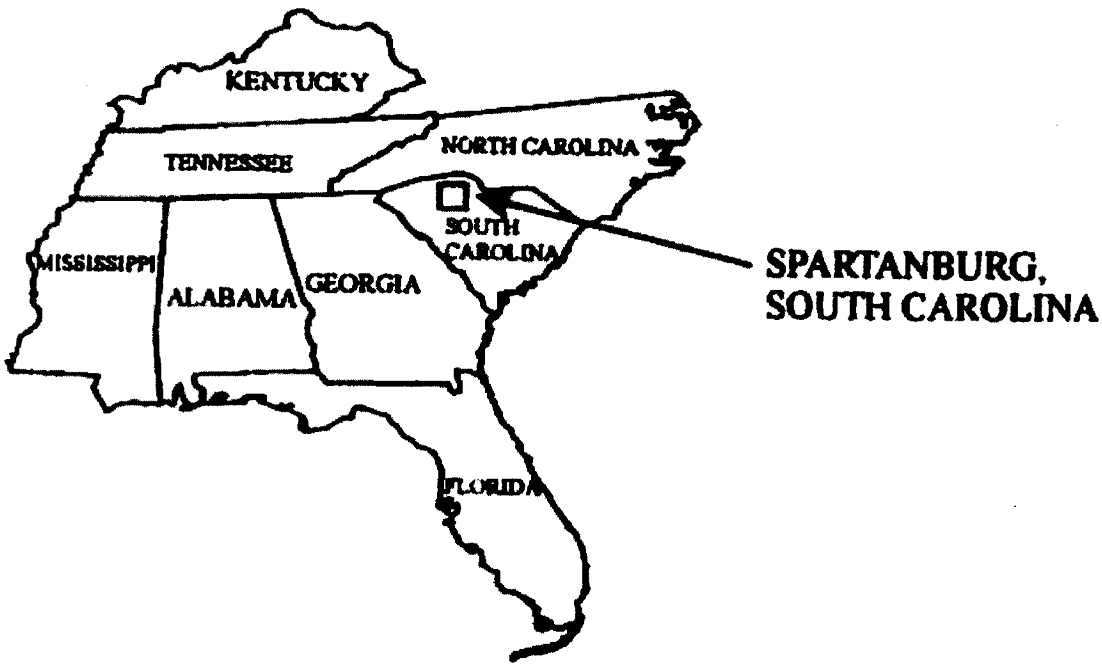


Figure 2
Industrial Properties in the Vicinity of the IMC Site

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 Site History

IMC Global, Inc., or related companies, including International Minerals and Chemical Corporation and IMC Fertilizer Group – Rainbow Division, owned or operated the facility from about 1910 until closure of the facility in 1986. During that time, the facility was operated for nitrogen-phosphorus-potassium (NPK) fertilizer production. Typical fertilizer manufacturing operations during the time included the use of phosphate rock to produce superphosphate as well as the use of other types of raw materials, including fish scraps, bone meal, and cotton hulls, as sources of plant nutrients. **Figure 3** illustrates a facility layout for former fertilizer manufacturing operations (*circa*. 1953). Limited information is available regarding operations at the Site before approximately 1947. As of approximately 1947, there were three primary operations at the Site. Those site operations included the following:

- A sulfuric acid production process which was constructed in 1947 and operated until 1970
- A superphosphate production process which continued operation until 1986
- A fertilizer mixing operation that continued, with process modifications, until 1986

Sulfuric Acid Production Plant

The sulfuric acid plant appears to have been constructed in approximately 1947 and likely began operations the following year. The plant was closed and dismantled in approximately 1970. In the manufacture of sulfuric acid, the plant used a "burner" to oxidize elemental sulfur and then added water to four lead-lined reaction chambers containing the oxidized sulfur. An aqueous sulfuric acid solution condensed in the reaction chambers and was collected and stored in aboveground on-site tanks within bermed concrete pads. The sulfuric acid was then used in the superphosphate production process. There was no waste stream associated with the production of sulfuric acid.

The sulfuric acid plant was located east of the main production and warehouse building (Fertilizer Building). Aerial photographs of the facility from the years of sulfuric acid plant operation suggest that the acid plant had a number of ponds - perhaps as many as five. Anecdotal evidence indicates that these ponds were used to store water from Fairforest Creek that would have been used in the acid production process.

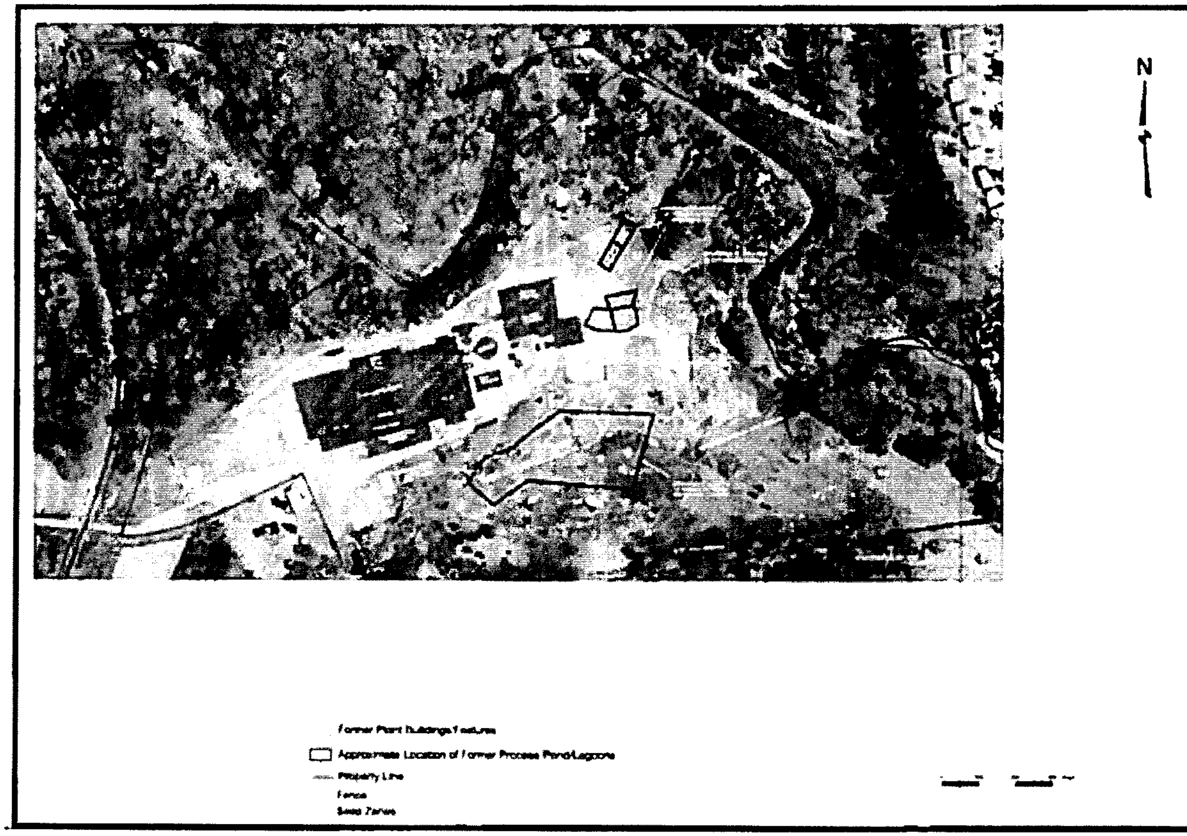


Figure 3- Facility Layout Map

The elemental sulfur for use in the process was received by rail. That material was stored outdoors at times, near the railroad-unloading trestle at the northeast corner of the plant. The acid plant was dismantled in approximately 1970. When the fertilizing mixing operation ceased in 1986, the sulfuric acid tanks were cleaned out **(Figure 4)**. The tanks were removed and sent off-site during deconstruction of the facility in 1999.

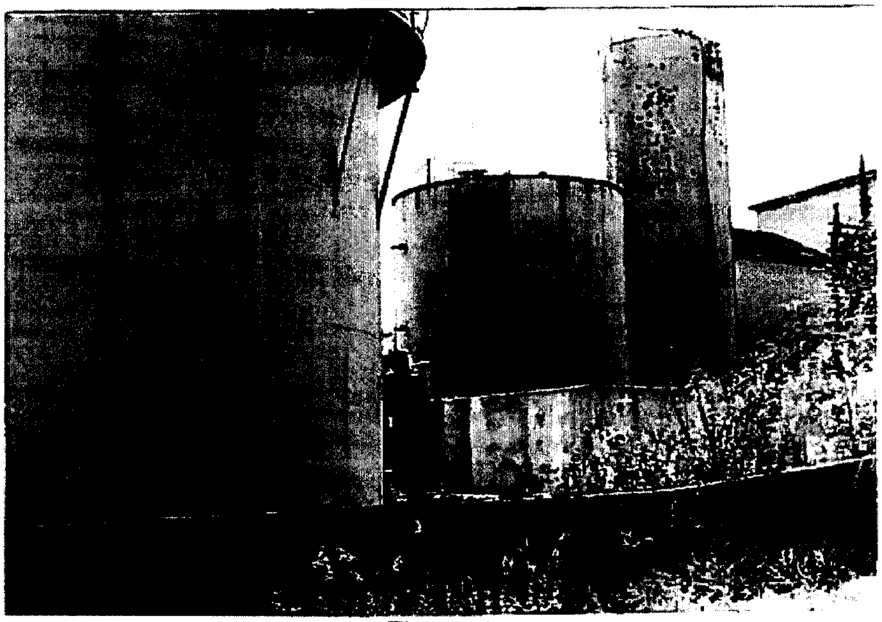


Figure 4
Former Sulfuric Acid Tanks

Superphosphate Production Process

Superphosphate was produced by combining sulfuric acid with phosphate rock, which was shipped to the plant by rail. Calcium sulfate or "gypsum" was not segregated during the superphosphate production process; instead, it remained with the superphosphate and was sold as part of the product. Thus, the Site did not have gypsum stacks.

Available information indicates that the production of superphosphate occurred in a "mixing den" into which phosphate rock and sulfuric acid were added. Because the mixing of sulfuric acid and phosphate rock is an exothermic reaction, the superphosphate product was able to flow from the mixing den to a cooling bin where it cooled and hardened. The cooling bin was apparently located in the Fertilizer Building. Former plant personnel have indicated that off-specification superphosphate was reprocessed through the superphosphate production process.

Records indicate that the superphosphate production process had a wet scrubber system associated with it. The scrubbers collected particulate matter and other emissions from the superphosphate process. Scrubber water, and any materials captured by the scrubbers, appears to have discharged to scrubber lagoons located south of the Fertilizer Building.

Fertilizer Mixing Process

Before the early to mid-1960s, the plant also made pulverized fertilizer by mixing a number of dry sources of nitrogen, potassium, and phosphate into a fertilizer product. Raw materials for this mixing process likely included superphosphate, potash, fillers such as sand, limestone, or dirt, and a dry nitrogen source such as ammonium sulfate.

In the mid-1960s, the plant appears to have converted to the production of granulated fertilizer. In addition to the raw materials used in the pulverized fertilizer production process, several other raw materials including phosphoric acid, anhydrous ammonia, nitrogen solutions, and urea would have been used in production of mono-ammonium phosphate, di-ammonium phosphate, and triple super phosphate. From time to time in the 1980s, the plant also used small amounts of fertilizer micronutrients in the granulation process. It is possible that one of these micronutrients might have been electric arc furnace dust, which was a valuable source of zinc – a necessary crop nutrient. In general, the plant received very small quantities of micronutrients – usually one pallet of 50-pound bags – at any one time and used one or two pallets of such material per year. The pallets were stored in the Fertilizer Building near the loading dock.

During both the production of pulverized fertilizer and the subsequent production of granulated fertilizer, wet scrubbers were used to capture particulate and other emissions from the production process. Scrubber water, together with material captured by the scrubbers, was then discharged to the scrubber lagoons located south of the Fertilizer Building. The granulation process shut down in 1986.

Between the 1930s and 1950s, scrubber towers were added to the superphosphate production process. The scrubbers collected particulate matter and other emissions from the superphosphate process. Wastewater generated from emission control measures for the scrubbers was routed through drainage features to on-site settling ponds. Wastewater settling ponds (scrubber ponds), operated on the site as a component of the scrubber emission control process, were located in the south central portion of the property. Additionally, five small surface impoundments were located in the northeastern portion of the facility property and are known to have been active from the late 1950s until 1970.

Before approximately the mid-1970s, the plant had two primary lagoons, one of which was used to capture scrubber water and the other of which was used to capture plant sewage. After the plant received a municipal sewage treatment hookup, in approximately 1974, the lagoons were redesigned, with the old sewage lagoon divided into two lagoons and expanded. One of these new lagoons was used for scrubber water; the other was used to capture storm water. The old scrubber lagoon continued to be used for scrubber water.

In 1987, after the plant closed, the lagoons were cleaned and dredged. Dredged material was reworked into fertilizer products at other IMC fertilizer production facilities. The five small surface impoundments in the northeastern portion of the facility were also closed by backfilling. In 1987, IMC sold the property to Mr. William McDaniel. The property was used by subsequent owners to store textile equipment until approximately 1999. In 1999, Vigindustries, a wholly owned indirect subsidiary of IMC Global, Inc., voluntarily reacquired the property and initiated demolition of the remaining facility buildings **(Figure 5)**.

Figure 5
Photo of the demolition of the remaining buildings

Following demolition, only the security fence, some asphalt paving, the concrete floors to the main fertilizer building, the office and garage areas, and the former above ground bulk fuel storage area remain. The concrete potash storage area and a concrete pad north of the former trestle also remain. **Figure 6** shows a current photo of the Site.

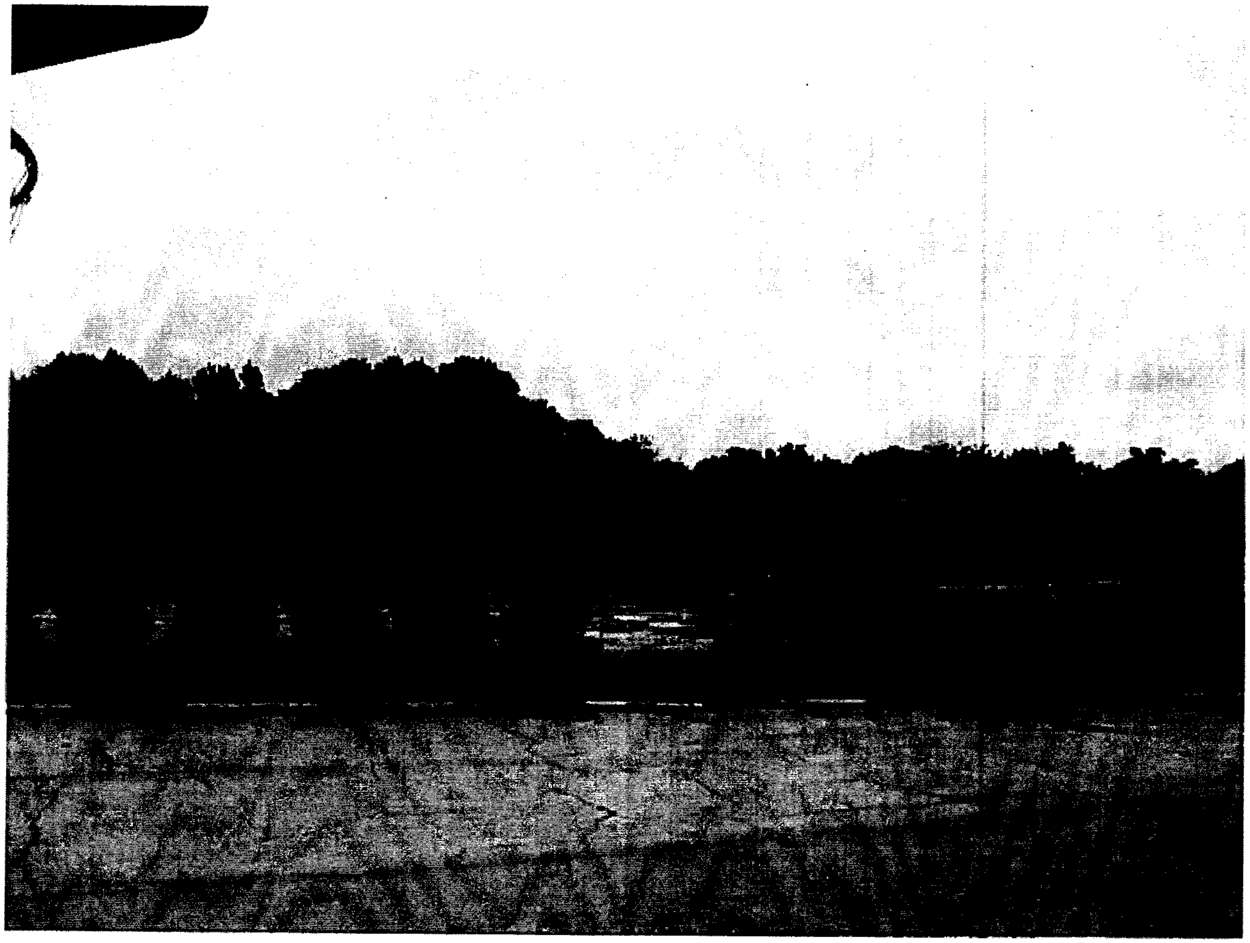


Figure 6 – Site Photo 2011

A small below ground explosives bunker was located near the eastern end of the facility. This bunker was inspected by EPA during site demolition activities in 1999. The bunker was found to be empty and no further action was required (**Figure 7**).

Figure 7 – Explosives Bunker

2.2 Previous Investigations and Enforcement Activities

A considerable amount of environmental data have been collected at the Site since closure of facility operations in 1986. Several hydrogeological assessments were initially conducted under the direction of the Wastewater Division of SC DHEC as part of closure of operating activities. In 1998, EPA began to conduct assessments of the Site.

In September 1991, the potentially responsible party (PRP) performed a preliminary site assessment (PSA) for the Industrial Wastewater Division of SC DHEC. During the PSA, groundwater, surface water and surface soil samples were collected. Fluoride and lead were detected in unfiltered groundwater at concentrations exceeding their respective MCLs. Fluoride was also elevated in the unfiltered surface water sample.

Three hydrogeologic assessments were also conducted in December 1993, August 1994, and February 1995. Activities conducted included the installation of monitoring wells and sampling and analysis of new and existing monitoring wells. Analyses of groundwater samples collected indicated the presence of metals, which exceeded primary and secondary MCLs. Groundwater at the facility was determined to flow eastward toward Fairforest Creek. The assessments recommended that continued groundwater monitoring be conducted.

In September 1998, EPA conducted a site inspection (SI). The primary objective of the SI was to support generation of a hazard ranking system (HRS) score to determine if the site warranted placement on the National Priorities List (NPL). Surface soil samples were collected from previous operational areas and from the former wastewater ponds. The SI reported that several inorganic constituents were present in surface soil over background concentrations. Groundwater samples were collected from five on-site monitoring wells and from a residential well located on North Street. The predominance of detections in groundwater was associated with inorganic compounds. Six surface water and sediment samples (two background) were collected from Fairforest Creek. Two additional sediment samples were collected upgradient and downgradient of the Site from the unnamed tributary (southern stream). Only one inorganic compound (manganese) in surface water and one inorganic (sodium) in sediments exceeded background criteria. The SI recommended that additional data be collected for the Site.

In January 2000, EPA conducted an expanded site inspection (ESI) at the site. The ESI included collection of 6 surface soil samples, 7 subsurface soil samples, 15 sediment samples, and 15 surface water samples. ESI samples were analyzed for the volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) on the target compound list (TCL), including pesticides and PCBs, and inorganic compounds on the target analyte list (TAL). Dioxin and furan analyses were performed on 5 surface soil and 5 sediment samples. Radiochemical analyses were also performed on 5 surface soil samples and samples from all 15 sediment sampling locations. The ESI recommended that further studies be conducted at the Site.

Under a permit with the wastewater division of SC DHEC, IMC agreed to conduct semiannual groundwater sampling of site monitoring wells. Seven on-site groundwater monitoring wells and surface water from two locations in Fairforest Creek were sampled on a routine basis. Groundwater and surface water samples were analyzed in the semiannual events for site-specific inorganic parameters. The semiannual groundwater monitoring program was discontinued following the December 2003 event due to the initiation of remedial investigation (RI) field activities.

To assist in project planning for the upcoming RI/feasibility study (FS), site reconnaissance activities were conducted in January and February 2001. Thirty-eight test pits were advanced across the Site to assist in the visual delineation of areas potentially used during historic facility operations for the disposal of plant debris and to determine the location and extent of residual wastewater solids in the former pond area.

In July 2001, EPA and Vigindustries entered into an administrative order by consent (consent order) to conduct an RI/FS and a removal action at the IMC Site.

Prior to the initiation of the RI/FS investigation activities, residual fertilizer and process materials in the area of the former manufacturing operations were delineated, removed, and properly disposed. These focused removal action activities were conducted between July and December 2002 in accordance with the final focused removal action workplan. The purpose of the focused removal action was to reduce available exposure/migration pathways and reduce potential exposure concentrations. Three removal action areas (RAAs) were identified. The three RAAs are shown on **Figure 8**.

A description of the three removal areas is as follows:

Removal Action Area No. 1 (RAA #1) - Fertilizer residuals and entrained surface soils located immediately adjacent to the southern and eastern portions of the former manufacturing structures.

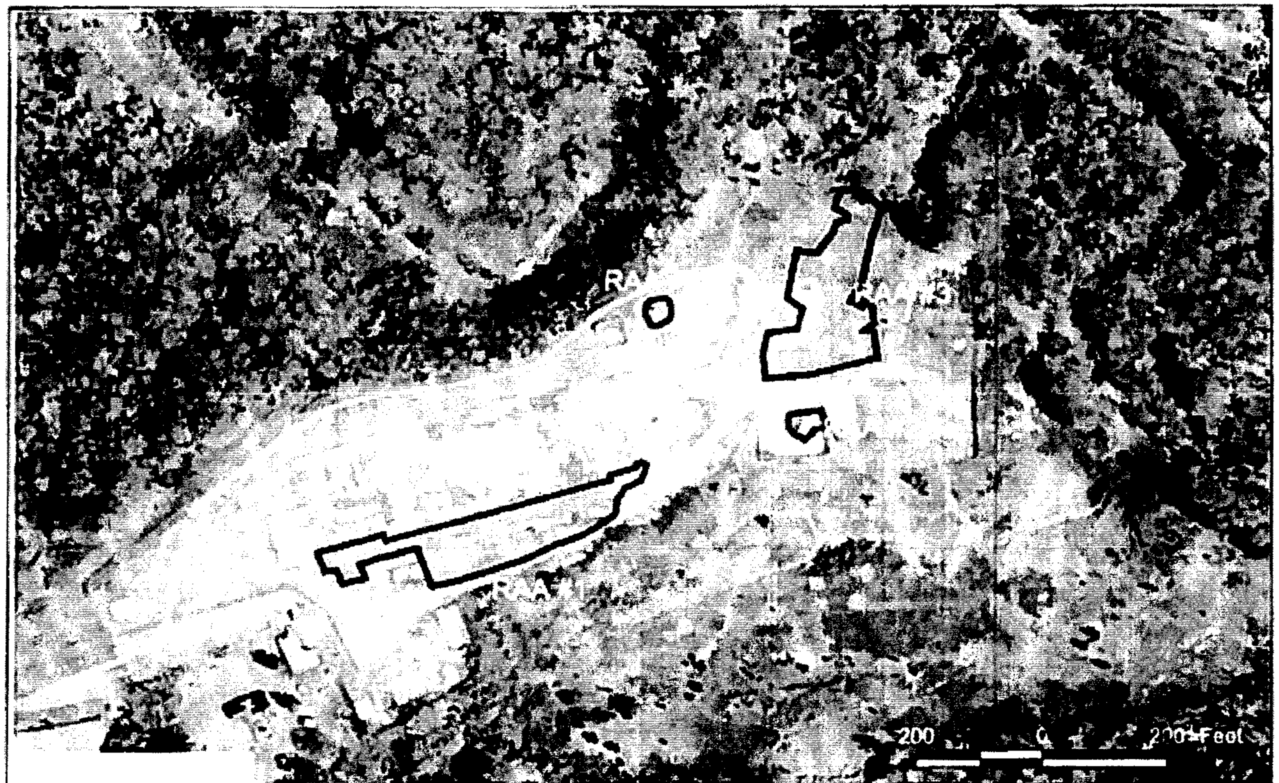
Removal Action Area No. 2 (RAA #2) - Two existing stockpiles of fertilizer-containing soils; one located adjacent to the former trestle and one located in the former potash storage area in the southern portion of the facility.

Removal Action Area No. 3 (RAA #3) - The area encompassing the five small closed surface impoundments located in the northeast and eastern portions of the facility property.

Approximately 4,500 tons of soil were removed from the three RAAs and sent off site for disposal at the Republic Landfill in Union County, South Carolina. Soils in these areas were excavated, sampled for disposal characterization, and transported to the landfill as nonhazardous material. Approximately 11,000 tons of soil were removed from RAA #3B and RAA #3C. Soils from these areas were treated in situ prior to loading and transport for off-site disposal. Following in situ treatment and prior to loading, samples were collected from treated soils to verify that they were nonhazardous. Grab samples from the sidewall locations and excavation bottoms were collected to provide a screening level evaluation of excavation completion prior to confirmation sampling. The samples were analyzed for total lead. The target lead level was 750 ppm. Based on indications from the screening level grab samples, removal activities were deemed to be complete. EPA approved the RI/FS work plan in May 2004.

3.0 COMMUNITY PARTICIPATION

Public participation activities prior to the issuance of this ROD included community interviews for the preparation of a Community Involvement Plan in January 2007, and the distribution of fact sheets in October 2001, January 2003, August 2003, June 2004, April 2007, January 2008 and June 2014. Copies of all project documents are available in the Administrative Record file in EPA's Region 4 office in Atlanta, Georgia and at



FORMER IMC FERTILIZER SITE
SPARTANBURG, SOUTH CAROLINA

LOCATION OF REMOVAL ACTION AREAS

Figure 8

the Spartanburg County Public Library on Church Street in Spartanburg, SC. The notice of the availability of these documents was published in the Spartanburg Herald on June 10, 2014. The public meeting was held on June 26, 2014. The public comment period began on June 9, 2014 and concluded on July 9, 2014.

4.0 SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

The IMC Site was addressed as one operable unit during the PRP-lead RI/FS. The scope of the investigation was to determine the nature and extent of contamination at the Site, including process residuals, soil, and groundwater, as well as surface water and sediment in Fairforest Creek. Section 5 further discusses the nature and extent of contamination in more detail.

This ROD selects actions that will remediate groundwater contamination that pose unacceptable risks. Ingestion of contaminated groundwater extracted from the contaminated plume poses a current and potential future risk to human health because the concentration of contaminants exceeds maximum contaminant levels (MCLs) for drinking water (as specified in the Safe Drinking Water Act) or exceeds EPA's acceptable risk range for those constituents without a MCL. This action is a final action and will prevent current or future exposure to groundwater contamination above concentrations noted in Table 21.

Site-specific remedial action objectives (RAOs) are described in detail in Section 8 of the ROD. RAOs indicate the exposure routes that will be addressed through the remedial action in order to prevent exposure to site COCs.

5.0 SITE CHARACTERISTICS

This section of the ROD provides a brief comprehensive overview of the IMC Site's soils, geology, surface water hydrology, and hydrogeology; the sampling strategy chosen for the Site; the conceptual site model; and the nature and extent of contamination at the Site. Detailed information about the Site's characteristics can be found in the RI Report.

5.1 OVERVIEW OF THE SITE

The IMC Site is an approximately 41-acre site located in the Arkwright community just south of Spartanburg, Spartanburg County, South Carolina. The land uses in the vicinity of the Site include industrial, residential, and undeveloped properties.

5.2 SURFACE AND SUBSURFACE FEATURES

With the exception of the facility area, which is surrounded by a security fence, the Site is undeveloped. Within the facility area, the building foundations are still present; building demolition was completed in 1999. Just to the south of the fenced facility area is an open field where the former scrubber and sewage lagoons were once located.

The Site is characterized by 90 feet of relief. The facility area is located on a ridge that drops off sharply to the north towards Fairforest Creek and to the south towards the open field. The ridge slopes eastward towards Fairforest Creek. The portions of the property at the North Street Extension entrance (west end of the site) are typified by ground surface elevations of approximately 700 feet above msl. However, much of the property adjacent to Fairforest Creek to the east is no more than about 625 feet above msl.

Only one surface water body that flows year round is located on the Site. This surface water body, Fairforest Creek, borders the site on part of the northern and eastern property boundaries. Fairforest Creek is sinuous but flows primarily from the northwest to the southeast. The elevation of Fairforest Creek is about 610 feet above msl at the eastern portions of the site. Portions of the site are within its 100 year-floodplain. Generally, Fairforest Creek has an annual mean flow rate of approximately 39 cubic feet per second (cfs). In addition to Fairforest Creek, two unnamed tributaries that are oriented east-west are located in the southern portion of the site. These streams, referred to as the northern intermittent stream and southern stream, are shown on **Figure 9**. The northern intermittent stream is located in the open field in the area where the former scrubber and sewage lagoons were once located. This tributary drains eastward towards Fairforest Creek. The southern stream marks the southern property boundary of the site and is actually a ditch that was constructed to divert water from the western portion of the site around the former scrubber and sewage lagoons. The southern stream separates the site property from the Arkwright Dump property. This tributary also flows eastward and discharges into Fairforest Creek. Surface water runoff from northern portions of the Arkwright Dump drain into the southern stream.

The Site is located in the Inner Piedmont Physiographic Province of South Carolina and therefore, is underlain with massive crystalline bedrock. This province consists of massive crystalline igneous and metamorphic rocks with low permeability and is characterized by a moderate relief and gently sloping topographic features. The Cecil-Davidson-Pacolet soil association underlies the facility. The soils are unconsolidated

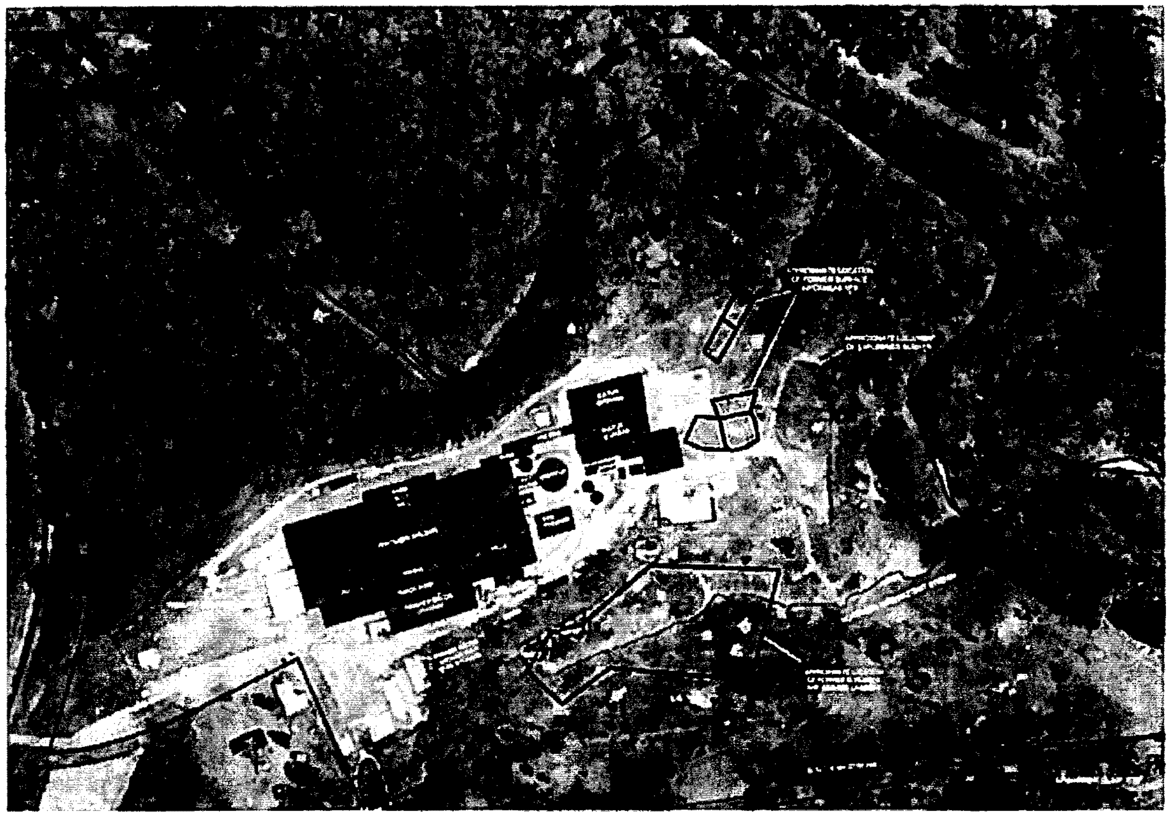


Figure 9
Surface Water Features

and are primarily derived from the in situ chemical weathering of the detrital bedrock. The unconsolidated material consists of both soil and saprolite and is collectively known as regolith. The regolith extends from ground surface to depths as much as 140 feet bls. The thickness of the regolith is generally proportional to the degree of bedrock fracturing. The Inner Piedmont Belt underlies the regolith. The Inner Piedmont Belt is composed of metamorphic rock types such as biotite gneiss, biotite schist, quartzite hornblende gneiss, and other gabbroic rocks.

Cross sections were prepared to illustrate hydrogeologic conditions at the Site. The locations of the cross sections are shown on **Figure 10** and cross section A-A' is shown on **Figure 11**. The remaining cross sections can be found in the RI Report. The depth to bedrock at the Site ranges from 17 feet bls at well location MW-7 A, adjacent to Fairforest Creek, to 49 feet bls at well location MW-12A, downgradient of the former sulfuric acid plant area. Boring descriptions indicate that bedrock consists of heavily fractured biotite mica schist in the southern portion of the Site, as indicated by well MW-4A and MW-5B, and by dense granitic gneiss along the eastern portion of the Site, as indicated by wells MW-7 A, MW-9A, MW-IIA, and MW-12A. Overlying the bedrock site-wide, saprolite was observed at depths varying from 4 feet to 14 feet bls. Weathered residual soils were observed above the saprolite throughout most of the site. Alluvial soils were observed above the saprolite in areas within close proximity to the Fairforest Creek. The presence of relic rock fabric (or structure) was used to differentiate between saprolite and soil (either residuum or alluvial).

The soils encountered at the Site are generally formed by in-place weathering of the underlying bedrock. The exception to this is the fill material and the wastewater/process residuals encountered in the southern and eastern portions of the site, in the vicinity of the former scrubber and sewage lagoons. Soils across the Site were generally described as sandy to silty clay and silty sand. The process residuals are visually distinct from the surrounding soils and were described primarily as gray silt. In some areas, residuals were further described as being clayey or sandy.

Groundwater in the area occurs in a complex, interconnected, two-media system composed of a zone of saprolite/regolith and the underlying fractured bedrock. Individual aquifers within the area are not extensive, and most of the water in the area is supplied by streams and lakes. The aquifer is usually unconfined; however, in some areas the saprolite acts as a confining unit due to its low permeability compared to underlying Piedmont rocks. Almost all groundwater recharge occurs by precipitation in the form of rainfall. The water table is generally found at the saprolite-bedrock interface. Most high-yield wells in the area are drilled to depths less than 250 feet bls because the number of fractures decreases with depth.

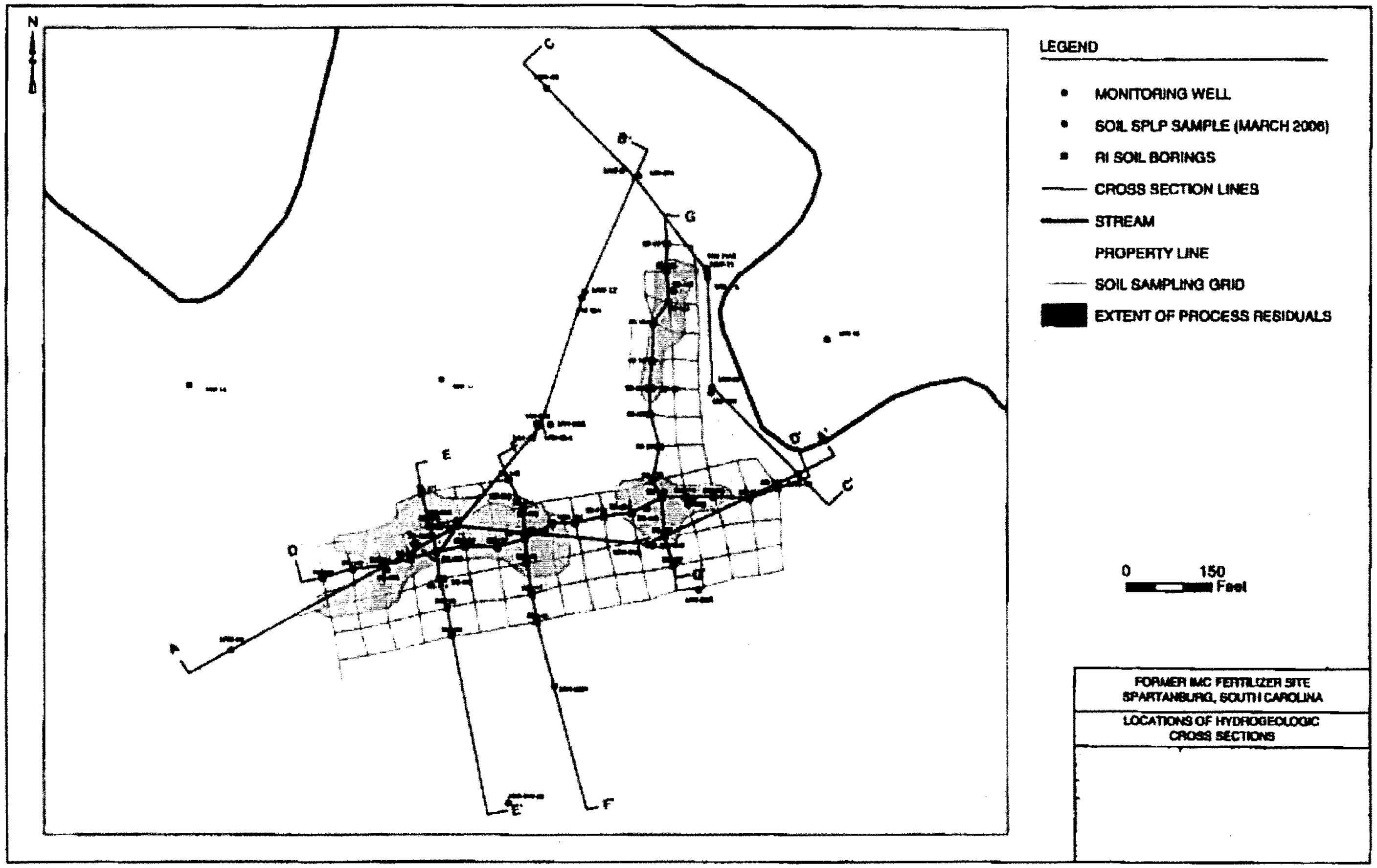

N
LEGEND
MONITORING WELL
SOIL SPLP SAMPLE (MARCH 2006)
RI SOIL BORINGS
CROSS SECTION LINES
STREAM
PROPERTY LINE
SOIL SAMPLING GRID
EXTENT OF PROCESS RESIDUALS
0
150
Feet
FORMER IMC FERTILIZER SITE
SPARTANBURG, SOUTH CAROLINA
LOCATIONS OF HYDROGEOLOGIC
CROSS SECTIONS

Figure 10

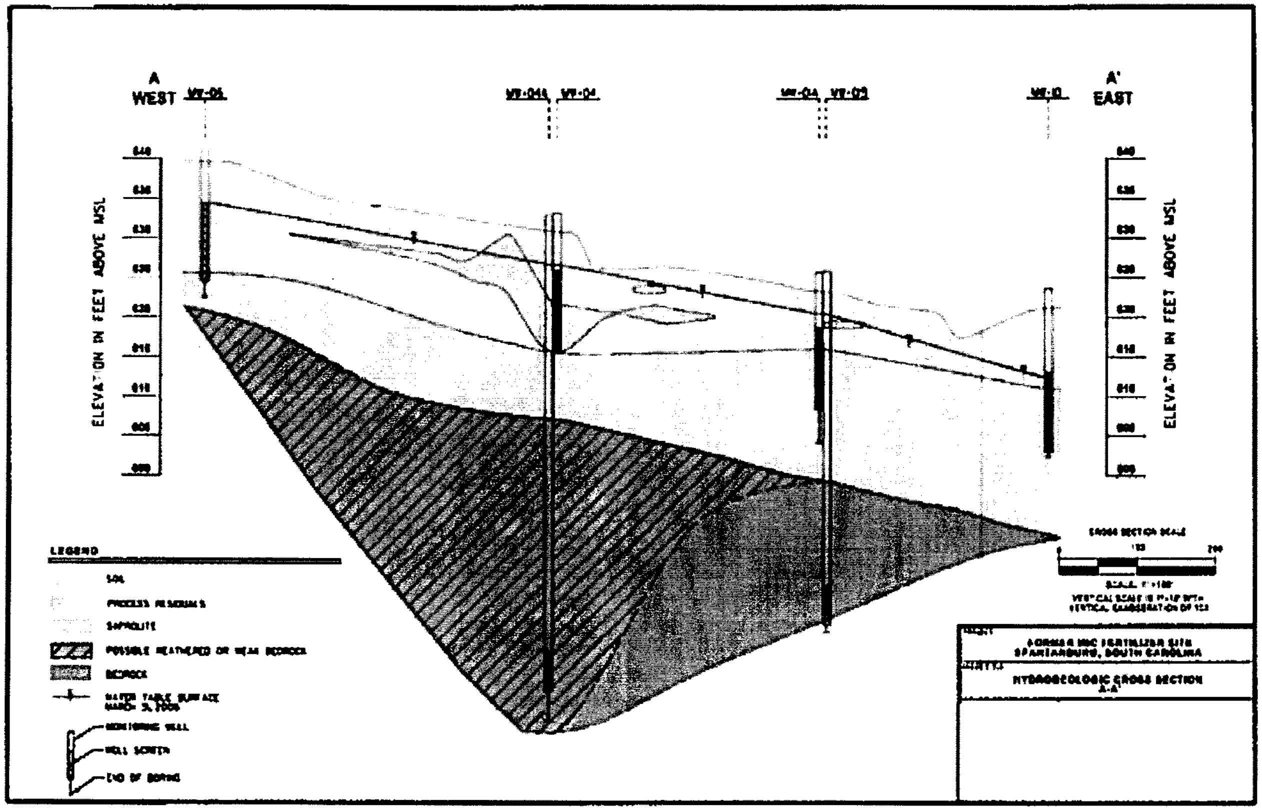

A
WEST
A'
EAST
ELEVATION IN FEET ABOVE MSL
ELEVATION IN FEET ABOVE MSL

Figure 11

The monitoring wells located on-site and one monitoring well located off-site are used to assess groundwater quality and site hydrogeologic conditions. The off-site monitoring well, MW-15 is located on the opposite side of Fairforest Creek from the Site (across from on-site well pair MW-9/9A). Water levels were measured in the on-site monitoring wells and staff gages as well as the monitoring wells located at the adjacent Arkwright Dump Site. These water levels were used to prepare the water table map presented in **Figure 12**.

Shallow groundwater at the Site occurs under water table conditions within the saprolite. Depth to groundwater ranges from approximately 64 feet bls at monitoring well MW-14 to approximately 2 feet bls at monitoring well MW-01A. Groundwater flow at the Site is to the north, northeast, and east towards Fairforest Creek. The lower surface water elevations in Fairforest Creek as compared to groundwater elevations in adjacent monitoring wells indicate that groundwater at the site discharges into Fairforest Creek. There is no indication of groundwater flow towards the southern stream, bordering the property to the south, or the Arkwright Dump Site.

Groundwater from the Arkwright Dump Site flows to the northeast towards the IMC Site and to the east towards Fairforest Creek. Groundwater in the northern portion of the Arkwright Dump Site appears to flow across the southeastern portion of the IMC property towards Fairforest Creek. A portion of this groundwater appears to discharge into the southern stream. Slug tests were performed to determine hydraulic conductivities for the aquifer. Slug tests were analyzed using the Bower and Rice methodologies. The average hydraulic conductivity for the water table wells was estimated to be 2.58 feet/ day with an effective porosity of 0.30 based on the type of soils observed at the Site. The estimated hydraulic gradient of the water table is 0.027 feet/foot. The average linear velocity for the water table aquifer is estimated to be 85 feet per year. Vertical gradients ranged from approximately -0.13 feet/feet in well pair MW-4/4A to +0.03 feet/feet in well pair MW-9/9A. Minor downward gradients were observed in well pairs indicate some connection exists between the upper saprolite, lower saprolite, and the underlying bedrock.

5.3 RI SAMPLING STRATEGY

The field sampling activities were conducted in two phases. The objectives developed for the Initial RI field activities were as follows:

• To assess the extent of residual process materials at the Site.

Figure 12
Water Table Configuration

• To refine the nature and distribution of site-related contaminants in surface and subsurface soils in the vicinity of potential source areas and other areas including the following **(Figure 13)**:

- Process residuals
- Soils in the vicinity of the Former Sulfuric Acid Plant, Raw Materials Process Area, and area east of RAA#3
- Soils on the northern side of the former manufacturing building
- Soils in the vicinity of the former office area
- Test pits
- Other areas

The objectives developed for the Supplemental RI field activities were as follows:

• To further assess the extent of process residuals on the eastern portion of the Site.

• To further refine the nature, distribution, and leaching potential of specific site-related COPCs in surface and subsurface soils including:

- Process residuals
- Soils in the vicinity of the Former Sulfuric Acid Plant, Raw Materials Process Area, and area east of RAA#3
- Soils on the northern side of the former manufacturing building

• To further understand the nature and distribution of site-related contaminants in groundwater, including groundwater near potential source areas at the Site.

• To further define groundwater flow characteristics and relationship to surface water bodies.

• To assess the presence of site-related contaminants in the sediment pore water beneath Fairforest Creek.

• To assess the presence of site-related contaminants in sediment, and surface water in Fairforest Creek.

Prior to conducting the RI investigation at the site, a radiation survey was performed. The radiation survey was generally conducted in the areas of the Site where the RI soil investigation was conducted. Ionizing radiation was measured at a total of 47 locations. Ionizing radiation measurements obtained during the survey were all similar and ranged from 11 μR/h to 45 μR/h at surface soil locations in the process residual area.

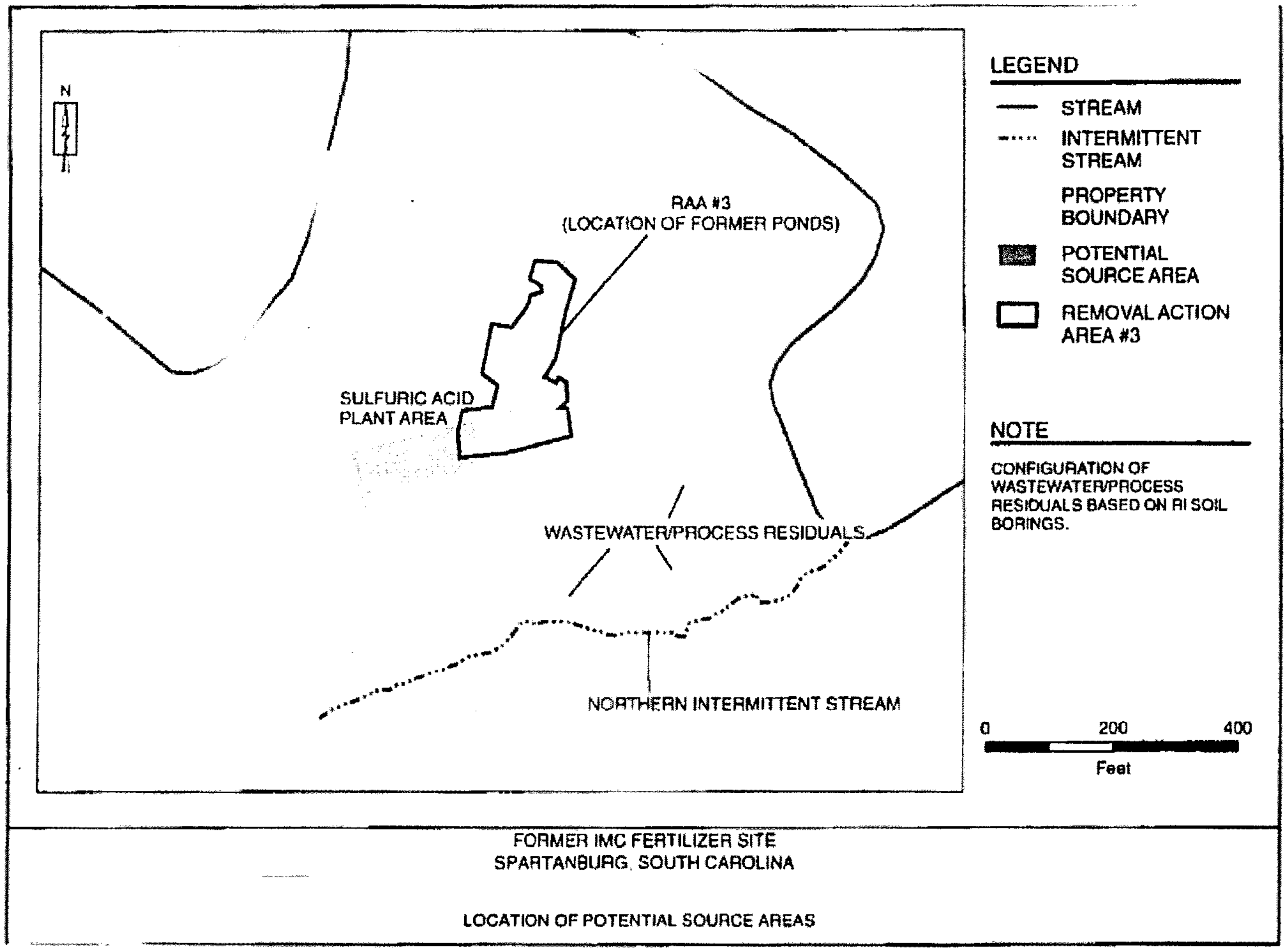

N
RAA #3
(LOCATION OF FORMER PONDS)
SULFURIC ACID
PLANT AREA
WASTEWATER/PROCESS RESIDUALS
NORTHERN INTERMITTENT STREAM
LEGEND
STREAM
INTERMITTENT
STREAM
PROPERTY
BOUNDARY
POTENTIAL
SOURCE AREA
REMOVAL ACTION
AREA #3
NOTE
CONFIGURATION OF
WASTEWATER/PROCESS
RESIDUALS BASED ON RI SOIL
BORINGS.
0
200
400
Feet
FORMER IMC FERTILIZER SITE
SPARTANBURG, SOUTH CAROLINA
LOCATION OF POTENTIAL SOURCE AREAS

Figure 13

Background locations had ionizing radiation measurements ranging from of 11.4 µR/h to 36 µR/h. Nearly all of the measurements made elsewhere at the Site fell between these two measured background values. Ionizing radiation measurements were consistent with background measurements.

5.4 Nature and Extent of Soil Contamination

Site areas have been divided into the following sub-areas based on former plant operations as well as historic focused areas of investigation:

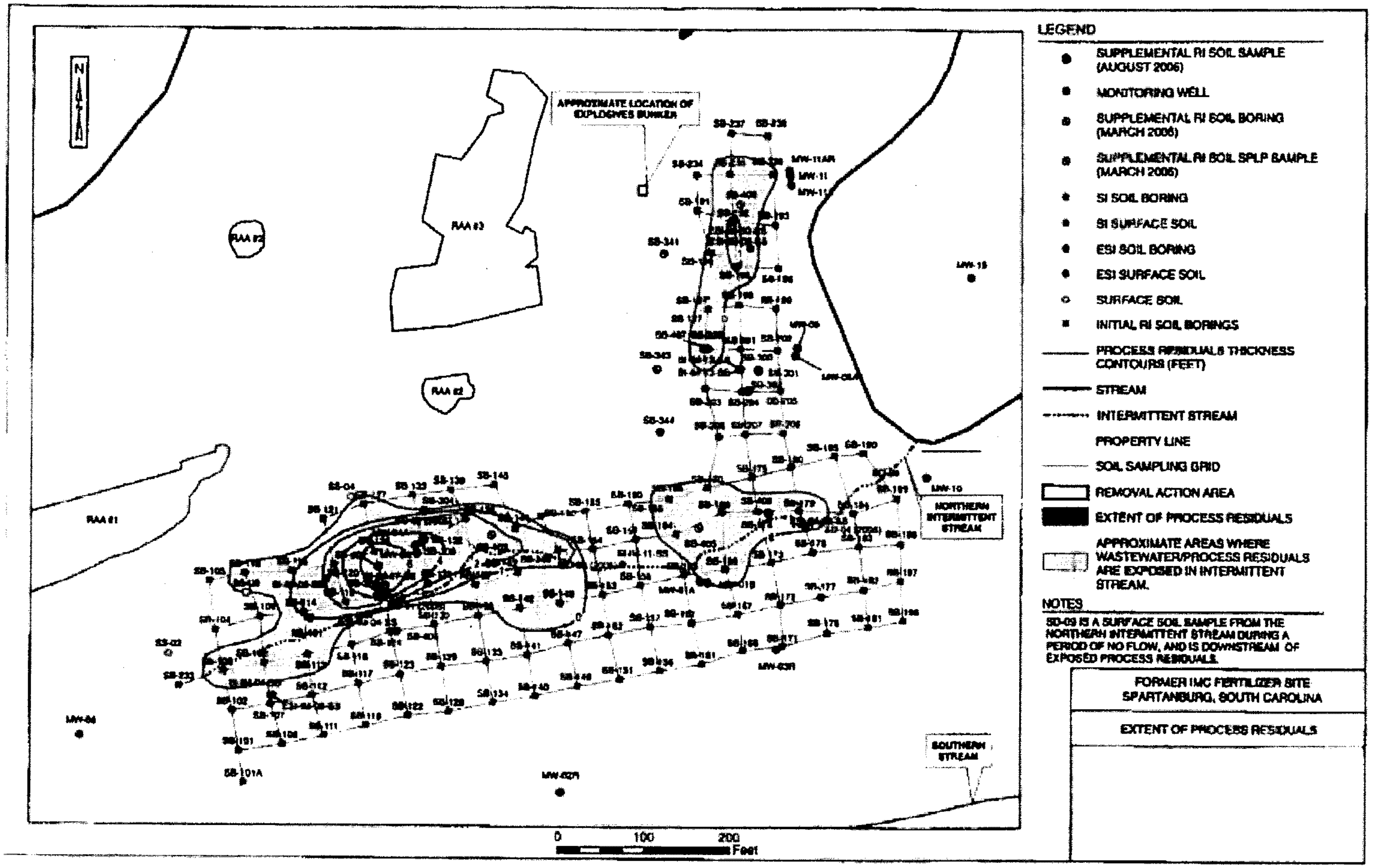
- Process Residuals Areas
- Former Sulfuric Acid Plant and Raw Materials Areas
- Remedial Action Area RAA#3
- Area North of Former Manufacturing Building
- Former Office Area
- Test Pits

Process Residuals Areas

Process residuals areas are those areas where residuals derived from facility manufacture of fertilizer and from air pollution control equipment were hydraulically placed. The three distinct areas of process residuals were visually identified in the field from inspection of soil borings and surface exposures in the northern intermittent stream. These three areas are defined as the: Southwestern Process Residuals Area, Southeastern Process Residuals Area, and Northeastern Process Residuals Area **(Figure 14)**.

Southwestern Process Residuals Area

The Southwestern Process Residuals Area represents over 80 percent of the residual mass of the three areas shown. This mass is estimated to consist of approximately 4,650 cy of wastewater/process residuals. The body of residuals is defined by a sediment basin (lagoon) centered on the northern intermittent stream. To address characterization of contaminants of potential concern (COPCs) in process residuals and the adjoining soils area to the south, investigations included samples that were analyzed for metals by both compositional and synthetic precipitation leaching procedure (SPLP) methods. RI results indicated levels of arsenic up to 37 mg/kg, leading to arsenic being included as a COPC in this area. RI results also indicated chromium concentrations up to 1604 mg/kg leading to chromium being included as a COPC in this area. Lead concentration levels ranged from 6.2 to 220 mg/kg in soil and process residuals samples from this area. Fluoride is a COPC characteristically related to the production of fertilizers. Fluoride concentrations ranged from 19 mg/kg to



APPROXIMATE LOCATION OF EXPLOSIVES BUNKER
NORTHERN INTERMITTENT STREAM
SOUTHERN STREAM
0 100 200
Feet
LEGEND
SUPPLEMENTAL RI SOIL SAMPLE (AUGUST 2006)
MONITORING WELL
SUPPLEMENTAL RI SOIL BORING (MARCH 2006)
SUPPLEMENTAL RI SOIL SPLP SAMPLE (MARCH 2006)
SI SOIL BORING
SI SURFACE SOIL
ESI SOIL BORING
ESI SURFACE SOIL
SURFACE SOIL
INITIAL RI SOIL BORINGS
PROCESS RESIDUALS THICKNESS CONTOURS (FEET)
STREAM
INTERMITTENT STREAM
PROPERTY LINE
SOIL SAMPLING GRID
REMOVAL ACTION AREA
EXTENT OF PROCESS RESIDUALS
APPROXIMATE AREAS WHERE WASTEWATER/PROCESS RESIDUALS ARE EXPOSED IN INTERMITTENT STREAM.
NOTES
SD-09 IS A SURFACE SOIL SAMPLE FROM THE NORTHERN INTERMITTENT STREAM DURING A PERIOD OF NO FLOW, AND IS DOWNSTREAM OF EXPOSED PROCESS RESIDUALS.
FORMER IMC FERTILIZER SITE SPARTANBURG, SOUTH CAROLINA
EXTENT OF PROCESS RESIDUALS

Figure 14

14,000 mg/kg The site-specific soil screening level (SSL) for fluoride is 5.4 mg/kg. The sample results indicate that process residual samples typically have the highest observed concentrations (79 mg/kg to 16,000 mg/kg), while concentrations in soils beneath the process residual have lower concentrations (19 mg/kg to 710 mg/kg). While highly leachable, fluoride is assumed to be a widely distributed COPC within the process residuals area. 2,4-DNT and 2,6-DNT were COPCs observed in the process residuals area at a concentration greater than the SSL of 0.0002 mg/kg. Process residual samples had 2,4-DNT and 2,6-DNT concentrations of 120 mg/kg and 3.5 mg/kg, respectively.

Southeastern Process Residuals Area

As with the Southwestern Process Residuals Area, the body of residuals is centered on the northern intermittent stream, however the body of process residuals is less than 1 foot thick. Process residual sample exposed in the northern intermittent stream at the downstream end of the area had an elevated arsenic concentration of 150 mg/kg, while the downstream soil sample had the lowest arsenic concentration of 2.3 mg/kg. Chromium was below the background concentration 76.7 mg/kg in samples from this area. Total lead concentrations were greater than the SSL of 400 mg/kg in process residual samples from three borings obtained from this area at concentrations of 410 mg/kg, 600 mg/kg, and 540 mg/kg. SPLP analyses indicate that lead is leachable from the process residuals area at levels exceeding the action level for lead in groundwater. Fluoride in process residuals concentrations ranged from 400 to 900 mg/kg. These fluoride concentrations are less than those detected in the Southwestern Process Residuals area, however the levels detected are significantly higher than the SSL of 5.4 mg/kg. SPLP analysis of fluoride indicates that fluoride may leach to groundwater from process residuals in this area. 2,4-DNT and 2,6-DNT are COPCs observed in the process residuals area at a concentration greater than the SSL of 0.0002 mg/kg

Northeastern Process Residuals and Adjoining Area

The thickness of process residuals in this area is generally less than 1 foot. There is no identifiable drainage ditch or stream through this limited area of process residuals. In the process residuals, chromium was below background concentrations, arsenic was greater than background concentrations in only one process residual sample and lead was present at concentrations greater than the SSL of 400 mg/kg. Fluoride ranged from 14 to 110 mg/kg (above the SSL of 4.5 mg/kg) in the four samples collected in this area. In the adjoining area, additional sampling was conducted to specifically delineate the extent of lead, selenium and PCBs adjacent to the south end of the process residual area. Lead was detected at concentrations ranging from 29 to 1,400 mg/kg. In addition selenium concentrations ranged from 1.1 to 1.6 mg/kg and PCBs were detected at a concentration of 23 mg/kg.

Former Sulfuric Acid Plant and Raw Materials Process Areas

The area of the Former Sulfuric Acid Plant and Raw Materials operations was investigated and arsenic, cadmium, lead and PCBs were determined to be COPCs in this sub-area. Samples were taken during the initial and supplemental RIs and none of the borings contained arsenic concentrations greater than the site-specific background of 12 mg/kg, thus the extent of arsenic above background is limited to surface soils at only two locations within this sub area. Samples were also analyzed for cadmium. Only one boring exhibited cadmium concentrations above background; therefore, the extent above background within the former sulfuric acid and Raw Process Materials area is limited. Lead was analyzed for and compared to the SSL of 400 mg/kg. Results from samples collected at borings showed concentrations of 600 and 590 mg/kg indicating that the extent of lead above the soil SSL in this sub-area is limited to a small area of surface soils. One soil boring (4.4 mg/kg) identified concentrations of PCBs above the SSL of 1 mg/kg during the Initial RI. Supplemental borings indicate that PCB concentrations greater than the SSLs in this sub-area is limited. 2,4-DNT was a COPC observed at only one location in this area of the site at a concentration (0.49 mg/kg) greater than the SSL of 0.0002 mg/kg.

Remedial Action Area #3 (RAA#3)

RAA#3 represents an area where soils from a group of five former impoundments were removed. Confirmation samples were collected within the footprint of the excavation, and RI samples were collected adjacent to but outside of the footprint to the east. Analysis of soil samples indicated the isolated presence of lead and PCB concentrations greater than SSLs in remaining soils. Lead is present above SSLs in one surface soil sample outside of the excavation footprint. PCB concentrations were greater than the SSL of 1 mg/kg at three isolated sampling points within the excavation footprint at concentrations of 15.7 mg/kg, 1.29 mg/kg, and 1.26 mg/kg. 2,4-DNT was observed at only two locations in this area of the site at concentrations greater than the SSL of 0.0002 mg/kg. 2,4-DNT was detected at concentrations of 0.051 mg/kg and 0.16 mg/kg.

Area North of Manufacturing Building

Two COPCs (arsenic and PAHs) were identified in the area north of the Manufacturing Building during the Initial RI and examined further in the Supplemental RI. Arsenic concentrations were detected above the background concentration of 12 mg/kg during the initial RI in soil in this area. Supplemental samples exhibited concentrations exceeding background for arsenic. The extent of arsenic above background was limited to the area of rail access to the former building and has been bounded by the wall of the building and the embankment to the north. This is the only contiguous area of arsenic concentrations above background on the Site, and may be related to railroad ballast or wood preservatives in the rail ties. PAHs were also detected in soil on the north side of the Former Manufacturing Building during the Initial RI and were further analyzed during the Supplemental RI. PAHs are not related to the production of fertilizer. PAHs may be related to creosotes that were contained within the wooden railroad ties found along the access to the building.

Former Office Area

COPCs were not detected above SSLs in this area of the Site.

Test Pits

Test Pits were advanced in the area east of the former potash storage area. Samples from the test pits were analyzed for arsenic and lead and observed concentrations were below background levels for both COPCs.

Other Areas

Other areas were investigated during the SI, ESI, and removal action phases. These include areas on the south side of the Former Building and outlier areas of the Site. No COPCs were identified in these other areas.

5.5 Nature and Extent of Groundwater Contamination

Groundwater at the Site is monitored via a network of monitoring wells **(Figure 15)**. Six of these locations consist of vertical well nests installed to monitor the extent of COPCs with depth. Analysis of groundwater flow characteristics indicated that groundwater from the site flows towards Fairforest Creek where it discharges. The Supplemental RI included a well located on the opposite side of Fairforest Creek from the Site, to assess the potential for groundwater flow beneath the Creek. In addition to groundwater sampling, RI investigations included extensive sediment pore water sampling along the site side of Fairforest Creek (see locations on **Figure 16**). Sediment pore water results were used to confirm and calibrate the geometry of groundwater distribution for the specific COPCs. Results of these investigations confirm that groundwater flow from the Site discharges at Fairforest Creek.

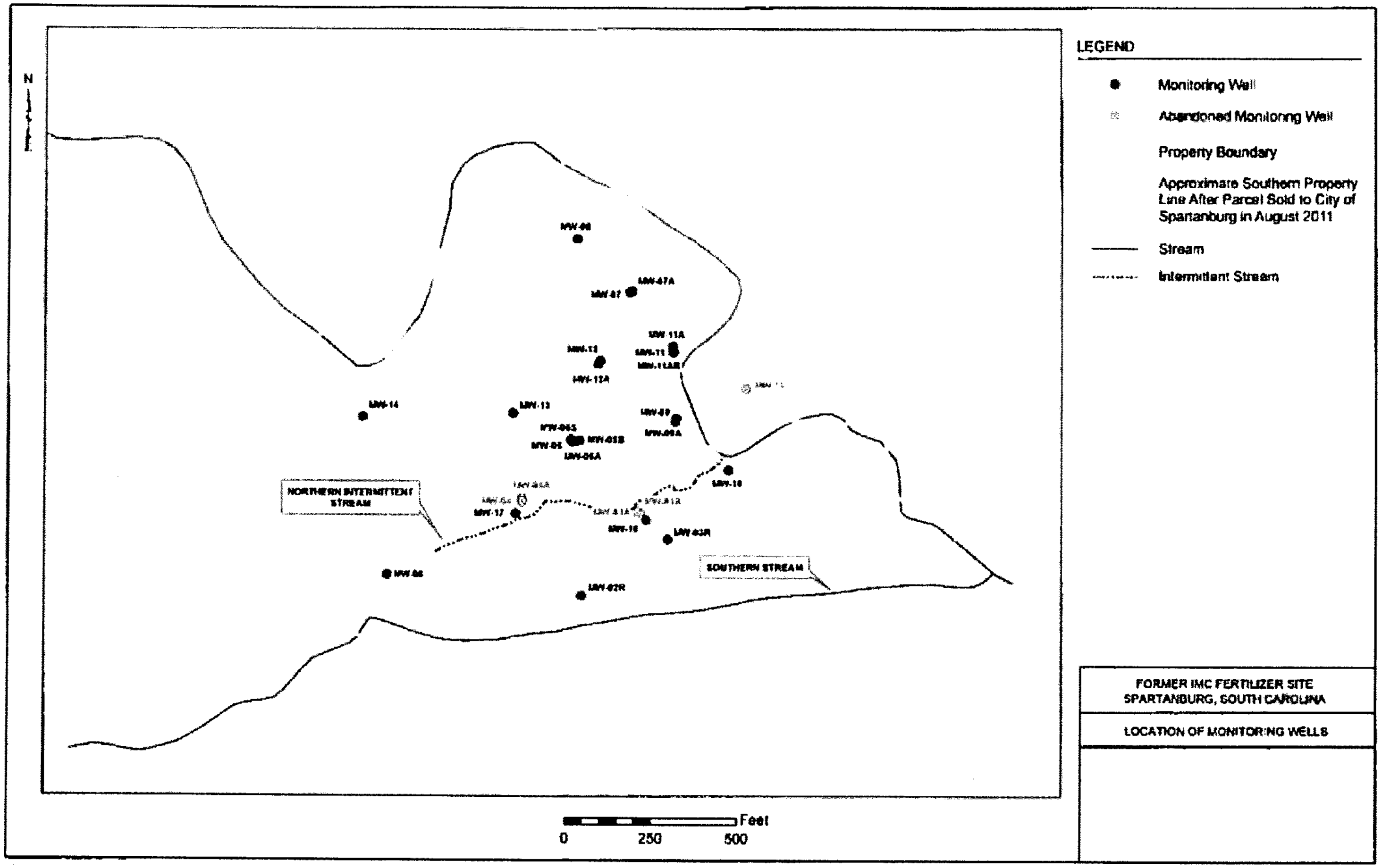
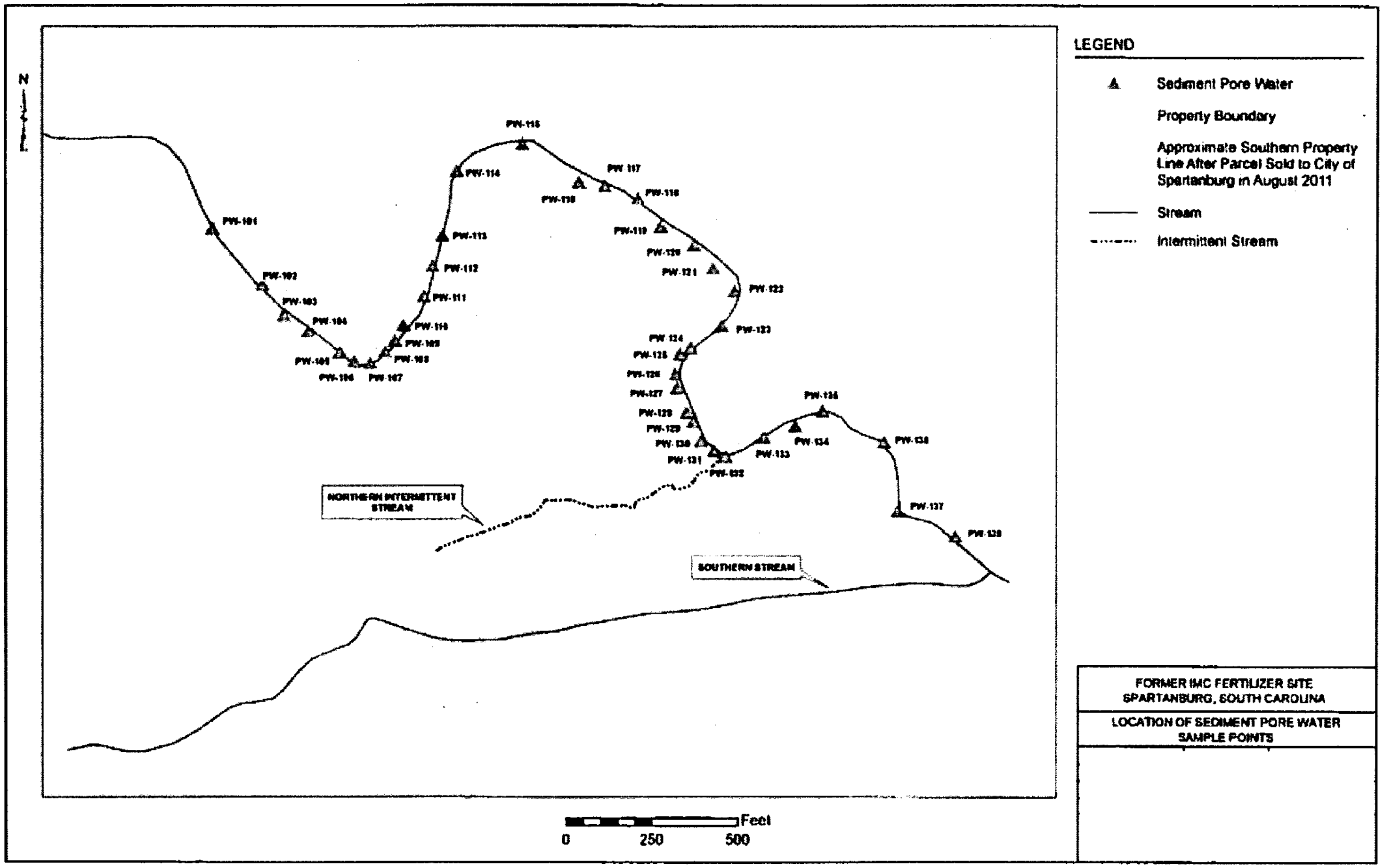

N
NORTHERN INTERMITTENT STREAM
SOUTHERN STREAM
LEGEND
Monitoring Well
Abandoned Monitoring Well
Property Boundary
Approximate Southern Property Line After Parcel Sold to City of Spartanburg in August 2011
Stream
Intermittent Stream
FORMER IMC FERTILIZER SITE
SPARTANBURG, SOUTH CAROLINA
LOCATION OF MONITORING WELLS
Feet
0
250
500

Figure 15



LEGEND
Sediment Pore Water
Property Boundary
Approximate Southern Property Line After Parcel Sold to City of Spartanburg in August 2011
Stream
Intermittent Stream
NORTHERN INTERMITTENT STREAM
SOUTHERN STREAM
Feet
0
250
500
FORMER IMC FERTILIZER SITE SPARTANBURG, SOUTH CAROLINA
LOCATION OF SEDIMENT PORE WATER SAMPLE POINTS

Figure 16

COPCs in groundwater include the following metals that exceeded federal and state maximum contaminant levels (MCLs) in groundwater during Supplemental RI sampling in 2006:

- Arsenic
- Beryllium
- Cadmium
- Lead
- Selenium
- Thallium

Results of analyses for VOCs performed in 2006 indicated that tetrachloroethene was below its MCLs, however, the following compounds were carried forward as COPCs in groundwater:

- Benzene
- Vinyl chloride

Wet chemistry and other analytes carried through as COPCs included the following:

- Fluoride
- Nitrate (as nitrogen)
- Gross Beta

The presence of a number of the above-listed COPCs is consistent with former fertilizer production operations. The distribution within groundwater for the majority of these COPCs correlates with either specific soil/process residual source areas, or with low pH observations related to operational source areas. Vinyl chloride concentrations; however are an exception, and likely indicate an upgradient source at the Arkwright Dump Site. To support the conclusion regarding the effects of pH on the plume geometry, **Figure 17**, an isoconcentration map of pH has been prepared.

Distribution of pH

Figure 17 illustrates the distribution of pH observations in site groundwater. The map clearly indicates that two separate source areas characterized by a pH <4 are present. One pH plume is derived from the area near the mass core of process residuals in the vicinity of MW-04 while the other appears to be emanating from the Former Sulfuric Acid Plant and Raw Materials Processing Areas. A minor plume (pH <5) is indicated to be discharging from the vicinity of MW-14. There is a strong correlation between the pH distribution and the geometry of the COPC distributions.

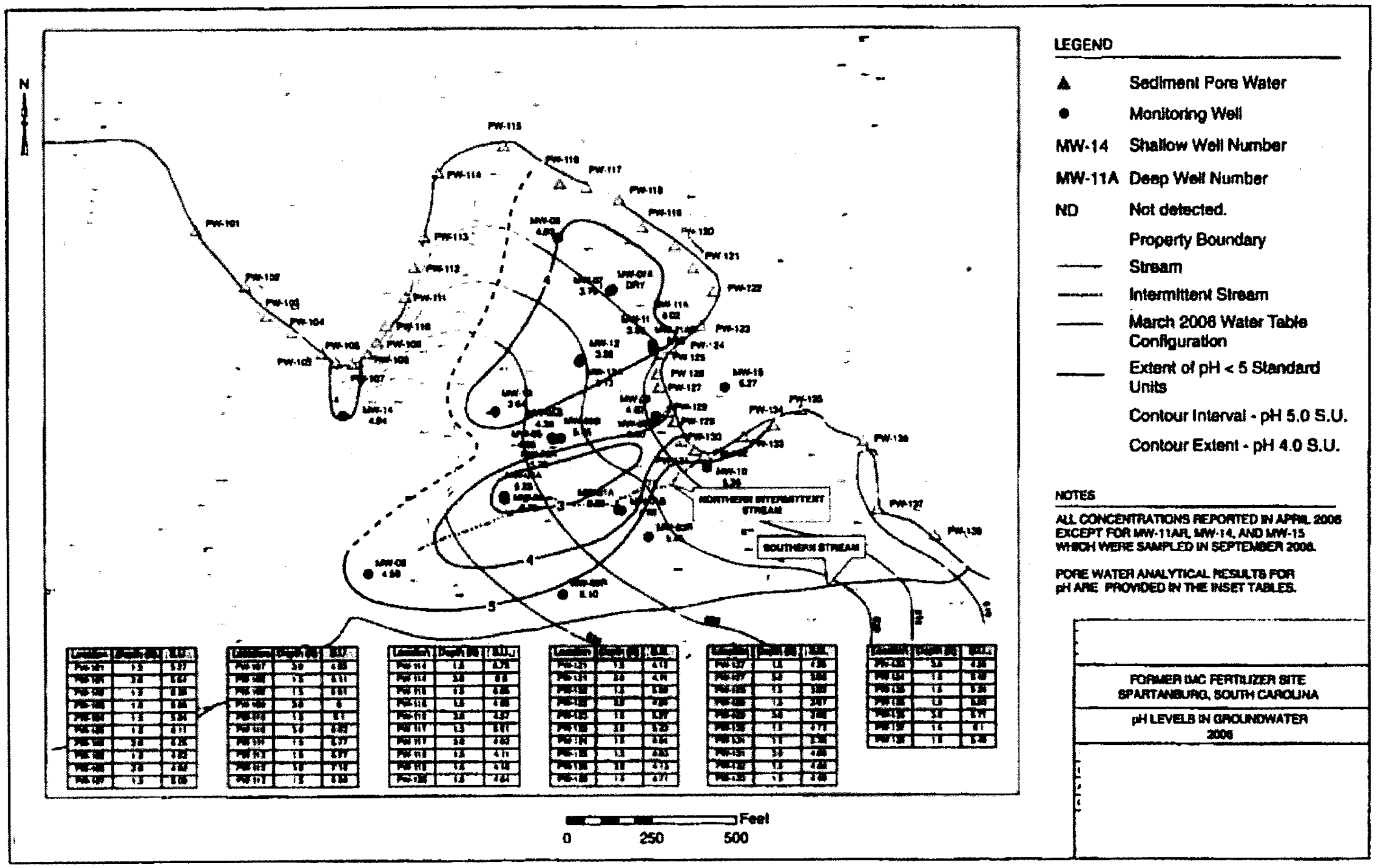

LEGEND
Sediment Pore Water
Monitoring Well
MW-14 Shallow Well Number
MW-11A Deep Well Number
ND Not detected.
Property Boundary
Stream
Intermittent Stream
March 2006 Water Table Configuration
Extent of pH < 5 Standard Units
Contour Interval - pH 5.0 S.U.
Contour Extent - pH 4.0 S.U.
NOTES
ALL CONCENTRATIONS REPORTED IN APRIL 2006 EXCEPT FOR MW-11AR, MW-14, AND MW-15 WHICH WERE SAMPLED IN SEPTEMBER 2006.
PORE WATER ANALYTICAL RESULTS FOR pH ARE PROVIDED IN THE INSET TABLES.
NORTHERN INTERMITTENT STREAM
SOUTHERN STREAM
FORMER IMC FERTILIZER SITE SPARTANBURG, SOUTH CAROLINA
pH LEVELS IN GROUNDWATER 2006
Feet
0
250
500

Figure 17

Inasmuch as most metallic COPCs found in the groundwater are not significant constituents in the manufacture of fertilizer, it is likely that acid water derived from hydraulically placed process residuals and from loss of acid process water in the Sulfuric Acid Plant and Raw Materials Process area have leached these COPCs from the native soil and saprolite units beneath the Site. While the original source of most of these COPCs is natural, the process of their leaching is the result of fertilizer production activities, an anthropogenic cause.

Figure 18 presents the distribution of arsenic concentrations in the groundwater. Two limited plumes of arsenic greater than the MCL of 0.01 mg/L are present, one plume in the vicinity of monitoring well MW-04 and the other plume in the vicinity of MW-07. Arsenic is not a significant constituent in fertilizer production. While arsenic is a COPC in soils, these groundwater observations are not coincident with elevated concentrations detected in soils, rather they appear to be related to low pH groundwater. Thus the source of arsenic is likely associated with acid leaching of natural formation minerals.

Figure 19 illustrates the distribution of beryllium in groundwater. Beryllium was not identified as a COPC in site soils for either risk-based or migration to groundwater considerations. The plume of beryllium exceeding the MCL of 0.004 mg/L appears to originate in the Former Sulfuric Acid Plant and Raw Materials Processing Areas. However, beryllium is not a significant constituent in fertilizer production and its presence in the groundwater appears to be related to low pH and subsequent dissolution from natural geologic formations.

The distribution of cadmium in groundwater is presented in **Figure 20**. While cadmium is a COPC in site soils, the geometry of the cadmium plume in excess of the MCL of 0.005 mg/L also appears related to low pH levels in the Former Sulfuric Acid Plant and Raw Materials Processing Areas. A minor contribution also appears to be coming from the core of the process residuals near MW-04, where pH values are also low. The source in groundwater is likely attributable to natural formation materials.

Two limited plumes of lead exceeding the EPA action level for lead in groundwater of 0.015 mg/L are present. One plume is limited to a small zone near Fairforest Creek and may be related to the Former Sulfuric Acid Plant and Raw Materials Process Areas. The other plume appears limited to the immediate area of MW-04 in the core of the process residuals.

Fluoride is a COPC in site soils and can be a significant component from the phosphate ore used as a raw material in the fertilizer manufacturing process. The sources of the

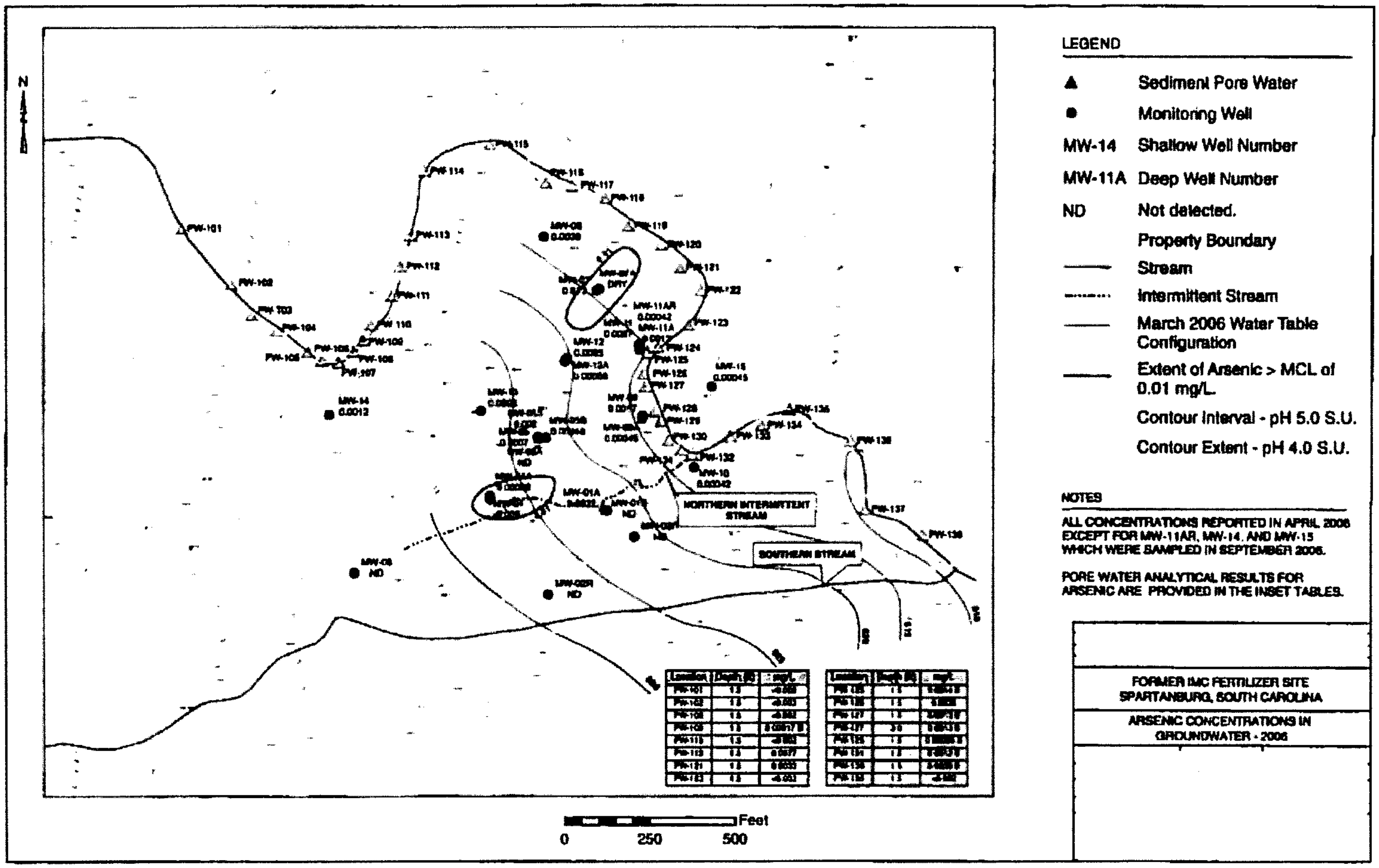

N
LEGEND
Sediment Pore Water
Monitoring Well
MW-14 Shallow Well Number
MW-11A Deep Well Number
ND Not detected.
Property Boundary
Stream
Intermittent Stream
March 2006 Water Table Configuration
Extent of Arsenic > MCL of 0.01 mg/L
Contour Interval - pH 5.0 S.U.
Contour Extent - pH 4.0 S.U.
NOTES
ALL CONCENTRATIONS REPORTED IN APRIL 2006 EXCEPT FOR MW-11AR, MW-14, AND MW-15 WHICH WERE SAMPLED IN SEPTEMBER 2006.
PORE WATER ANALYTICAL RESULTS FOR ARSENIC ARE PROVIDED IN THE INSET TABLES.
FORMER IMC FERTILIZER SITE
SPARTANBURG, SOUTH CAROLINA
ARSENIC CONCENTRATIONS IN GROUNDWATER - 2006
NORTHERN INTERMITTENT STREAM
SOUTHERN STREAM
Feet
0 250 500

Figure 18

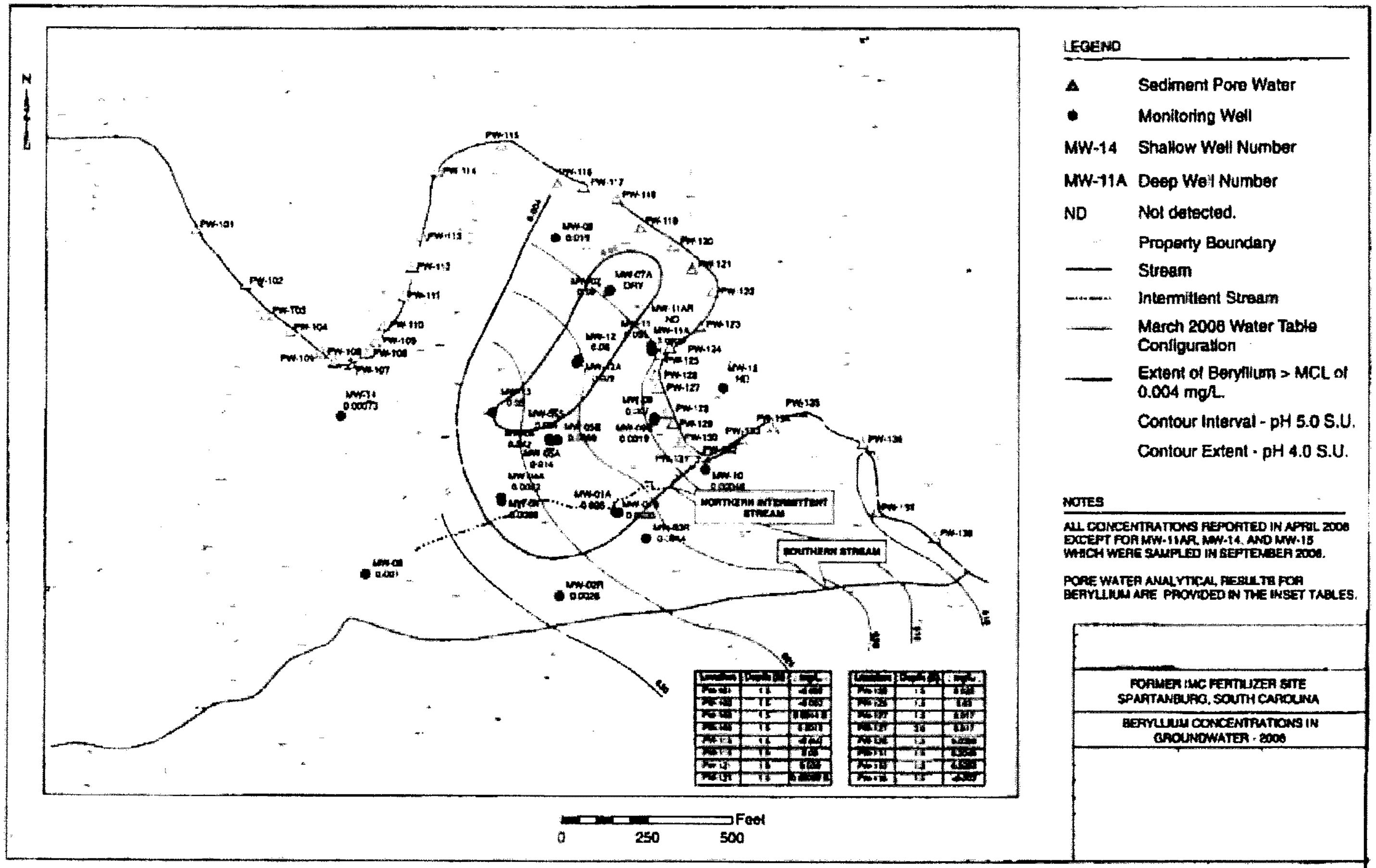

LEGEND
Sediment Pore Water
Monitoring Well
MW-14 Shallow Well Number
MW-11A Deep Well Number
ND Not detected.
Property Boundary
Stream
Intermittent Stream
March 2006 Water Table Configuration
Extent of Beryllium > MCL of 0.004 mg/L.
Contour Interval - pH 5.0 S.U.
Contour Extent - pH 4.0 S.U.
NOTES
ALL CONCENTRATIONS REPORTED IN APRIL 2006 EXCEPT FOR MW-11AR, MW-14, AND MW-15 WHICH WERE SAMPLED IN SEPTEMBER 2006.
PORE WATER ANALYTICAL RESULTS FOR BERYLLIUM ARE PROVIDED IN THE INSET TABLES.
FORMER IMC FERTILIZER SITE SPARTANBURG, SOUTH CAROLINA
BERYLLIUM CONCENTRATIONS IN GROUNDWATER - 2006
NORTHERN INTERMITTENT STREAM
SOUTHERN STREAM
Feet
0
250
500
N

Figure 19

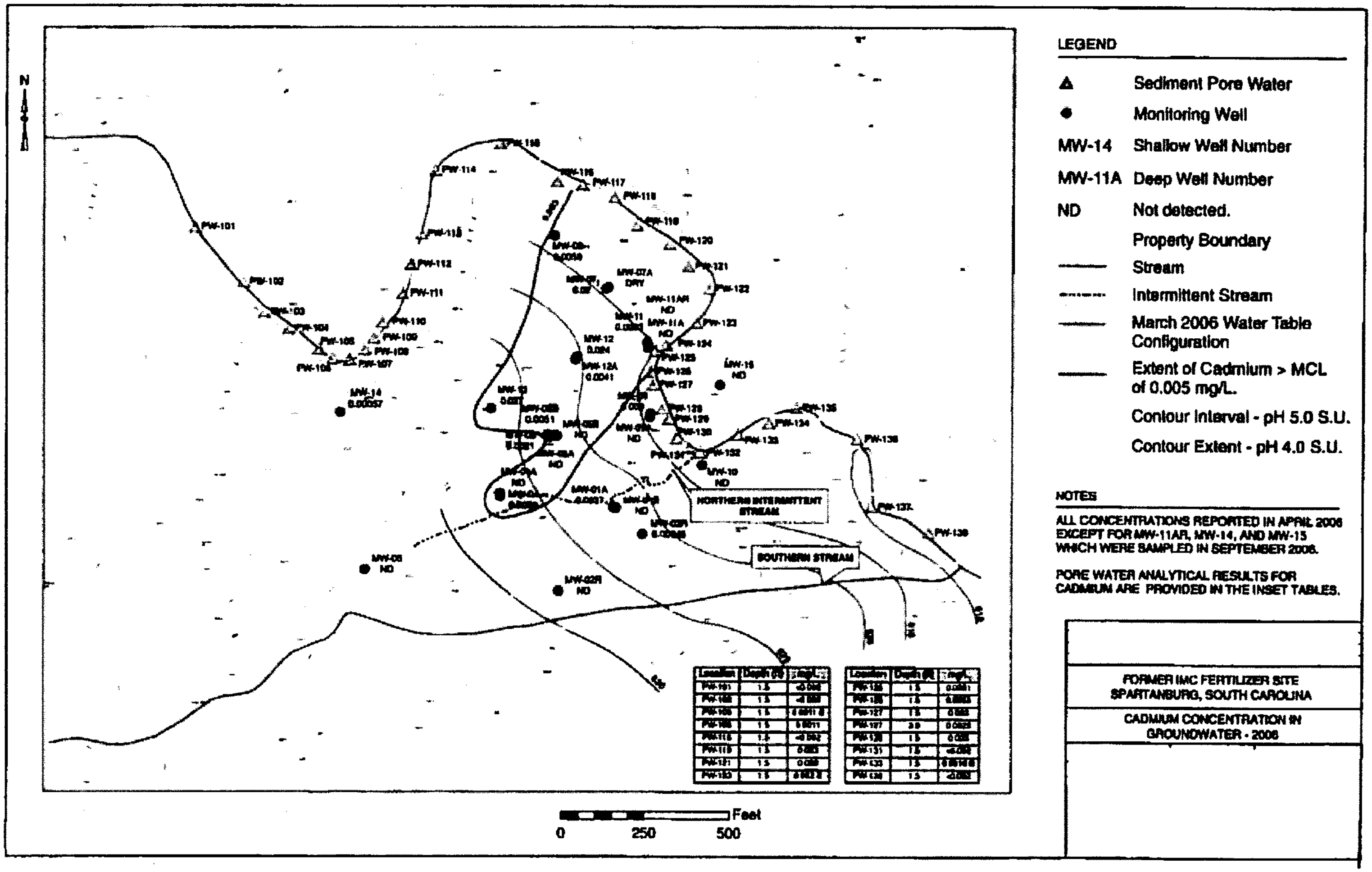

N
LEGEND
Sediment Pore Water
Monitoring Well
MW-14 Shallow Well Number
MW-11A Deep Well Number
ND Not detected.
Property Boundary
Stream
Intermittent Stream
March 2006 Water Table Configuration
Extent of Cadmium > MCL of 0.005 mg/L.
Contour Interval - pH 5.0 S.U.
Contour Extent - pH 4.0 S.U.
NOTES
ALL CONCENTRATIONS REPORTED IN APRIL 2006 EXCEPT FOR MW-11AR, MW-14, AND MW-15 WHICH WERE SAMPLED IN SEPTEMBER 2006.
PORE WATER ANALYTICAL RESULTS FOR CADMIUM ARE PROVIDED IN THE INSET TABLES.
FORMER IMC FERTILIZER SITE SPARTANBURG, SOUTH CAROLINA
CADMIUM CONCENTRATION IN GROUNDWATER - 2006
NORTHERN INTERMITTENT STREAM
SOUTHERN STREAM
Feet
0
250
500

Figure 20

fluoride in groundwater, as shown on **Figure 21**, are concentrated in two areas; (1) a plume greater than 200 mg/L has origin from the Former Sulfuric Acid Plant and Raw Materials Process Areas, and (2) a plume greater than 500 mg/L which has origin from the core of the wastewater/process residuals areas. Both of the plumes correlate highly with the observations of low pH in groundwater.

Nitrate is a significant component from the fertilizer manufacturing process. The source of the nitrate plume in groundwater, as shown on **Figure 22**, appears to be primarily from the Former Sulfuric Acid Plant and Raw Materials Process Areas with an additional contribution from the Process Residuals areas. A minor plume is also indicated in the area of monitoring well MW-14. The geometry of the nitrate distribution in groundwater correlates well with the low pH observations associated with former manufacturing operations.

Sulfate is also a significant component from the fertilizer manufacturing process. The sulfate plume closely mimics the pH plume. The plume exhibits two core areas, each with sulfate concentrations greater than 2,000 mg/L. **Figure 23** presents the distribution and concentrations observed in the monitoring wells. These core areas originate from the Former Sulfuric Acid Plant and Raw Materials Process Areas and the Southwestern Process Residual areas. A minor plume is also indicated in the area of monitoring well MW-14 on the north side of the former building.

Gross beta levels were measured in groundwater. The area of Gross beta that exceeds the Safe Drinking Water Act (SDWA) comparison criterion of 50 pico curies per liter (pCi/L) is contained within the low pH plume area. A limited detection of benzene greater than its MCL of 0.005 mg/L was observed at monitoring well MW-05. The presence of benzene in this area may be related to operations maintenance, as benzene is not a constituent in mineral fertilizer. Vinyl chloride was detected at monitoring well MW-02R in excess of the MCL of 0.002 mg/L. The source of the plume of vinyl chloride is indicated to be the Arkwright Dump Site which borders the Site to the south.

Although 2,4-DNT and 2,6-DNT were retained as COPCs for groundwater, there are no MCLs for comparison of the concentrations observed in the groundwater. Distribution of 2,4-DNT in groundwater is presented on **Figures 24**. Concentrations of 2,4-DNT ranged from 0.19 mg/L in samples collected from well MW-9 to 8.3 mg/L in samples collected from well MW-4. The highest concentrations of 2,4-DNT and 2,6-DNT have been observed in samples collected from monitoring well MW-4 located within the core of the southwestern process residual body. These results, along with analytical results for soil samples collected at the Site, indicate that the process residuals are the source of 2,4-DNT and 2,6-DNT found in groundwater at the Site and not the small explosives bunker located 500 feet northeast and semi-downgradient of MW-4.

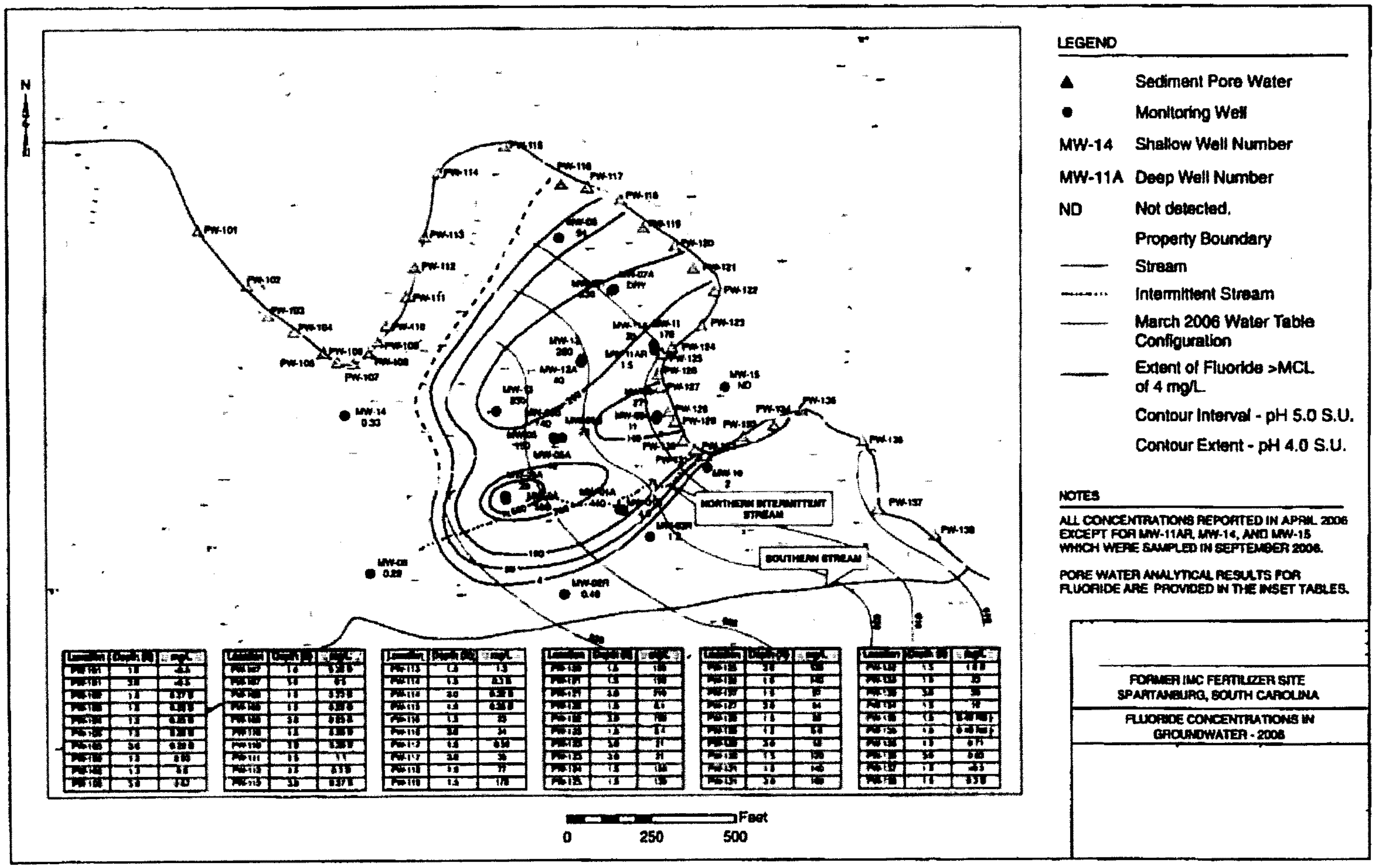

LEGEND
Sediment Pore Water
Monitoring Well
MW-14 Shallow Well Number
MW-11A Deep Well Number
ND Not detected.
Property Boundary
Stream
Intermittent Stream
March 2006 Water Table Configuration
Extent of Fluoride >MCL of 4 mg/L
Contour Interval - pH 5.0 S.U.
Contour Extent - pH 4.0 S.U.
NOTES
ALL CONCENTRATIONS REPORTED IN APRIL 2006 EXCEPT FOR MW-11AR, MW-14, AND MW-15 WHICH WERE SAMPLED IN SEPTEMBER 2006.
PORE WATER ANALYTICAL RESULTS FOR FLUORIDE ARE PROVIDED IN THE INSET TABLES.
FORMER IMC FERTILIZER SITE
SPARTANBURG, SOUTH CAROLINA
FLUORIDE CONCENTRATIONS IN GROUNDWATER - 2006
NORTHERN INTERMITTENT STREAM
SOUTHERN STREAM
Feet
0 250 500

Figure 21

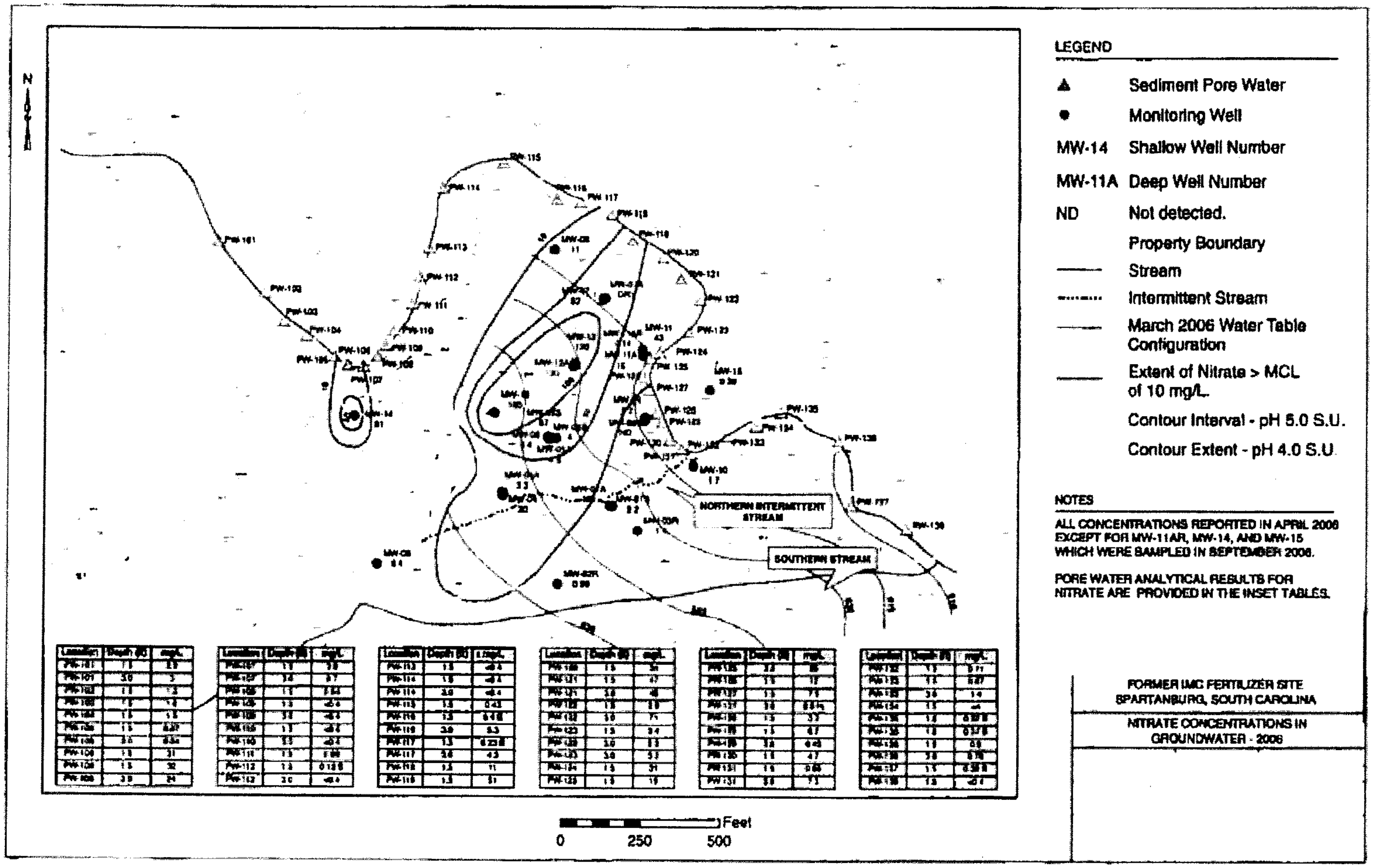
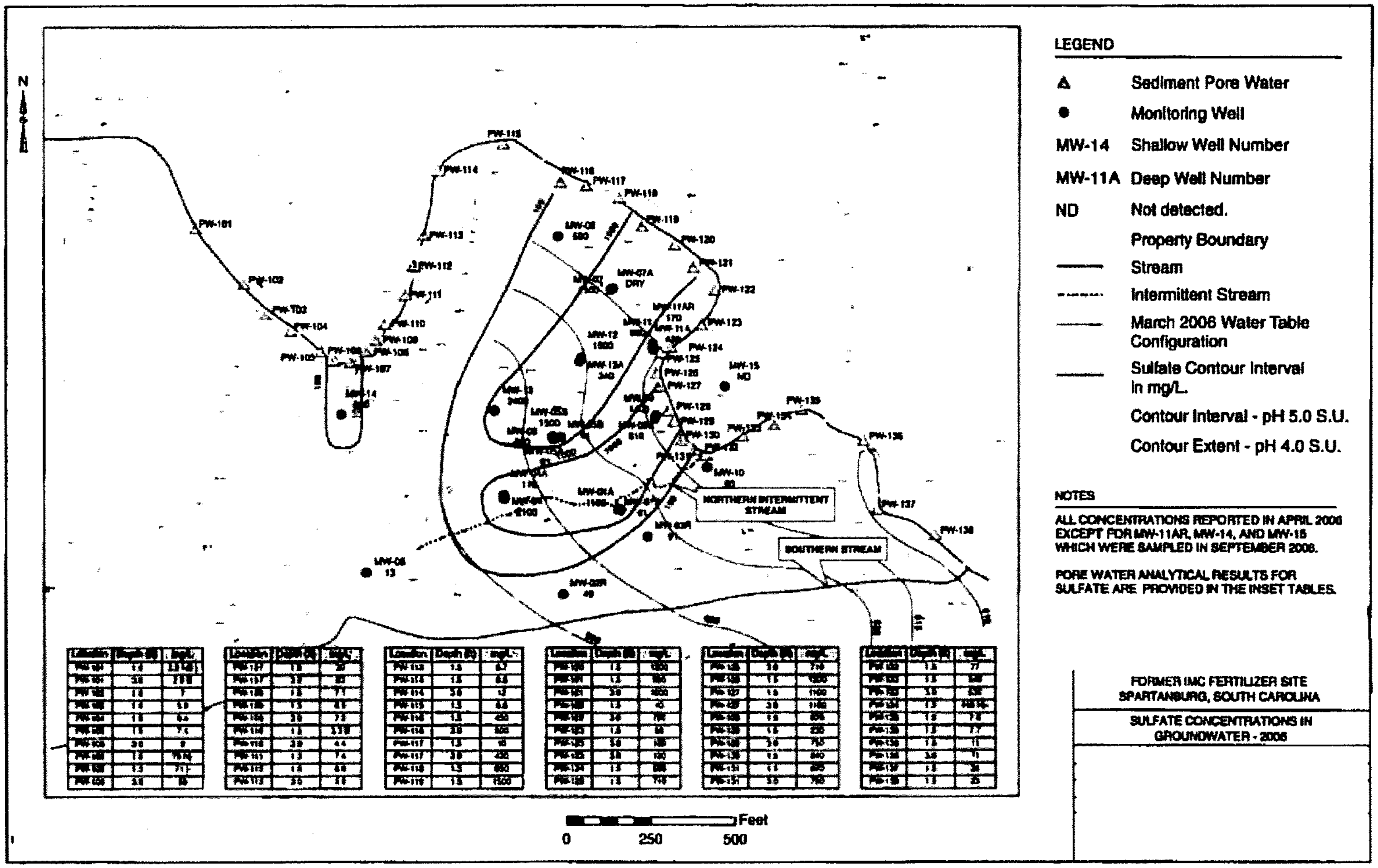

LEGEND
Sediment Pore Water
Monitoring Well
MW-14 Shallow Well Number
MW-11A Deep Well Number
ND Not detected.
Property Boundary
Stream
Intermittent Stream
March 2006 Water Table Configuration
Extent of Nitrate > MCL of 10 mg/L
Contour Interval - pH 5.0 S.U.
Contour Extent - pH 4.0 S.U.
NOTES
ALL CONCENTRATIONS REPORTED IN APRIL 2006 EXCEPT FOR MW-11AR, MW-14, AND MW-15 WHICH WERE SAMPLED IN SEPTEMBER 2006.
PORE WATER ANALYTICAL RESULTS FOR NITRATE ARE PROVIDED IN THE INSET TABLES.
FORMER IMC FERTILIZER SITE
SPARTANBURG, SOUTH CAROLINA
NITRATE CONCENTRATIONS IN GROUNDWATER - 2006
NORTHERN INTERMITTENT STREAM
SOUTHERN STREAM
N
Feet
0
250
500

Figure 22



LEGEND
Sediment Pore Water
Monitoring Well
MW-14 Shallow Well Number
MW-11A Deep Well Number
ND Not detected.
Property Boundary
Stream
Intermittent Stream
March 2006 Water Table Configuration
Sulfate Contour Interval in mg/L.
Contour Interval - pH 5.0 S.U.
Contour Extent - pH 4.0 S.U.
NOTES
ALL CONCENTRATIONS REPORTED IN APRIL 2006 EXCEPT FOR MW-11AR, MW-14, AND MW-15 WHICH WERE SAMPLED IN SEPTEMBER 2006.
PORE WATER ANALYTICAL RESULTS FOR SULFATE ARE PROVIDED IN THE INSET TABLES.
FORMER IMC FERTILIZER SITE SPARTANBURG, SOUTH CAROLINA
SULFATE CONCENTRATIONS IN GROUNDWATER - 2006
NORTHERN INTERMITTENT STREAM
SOUTHERN STREAM
N
Feet
0
250
500

Figure 23

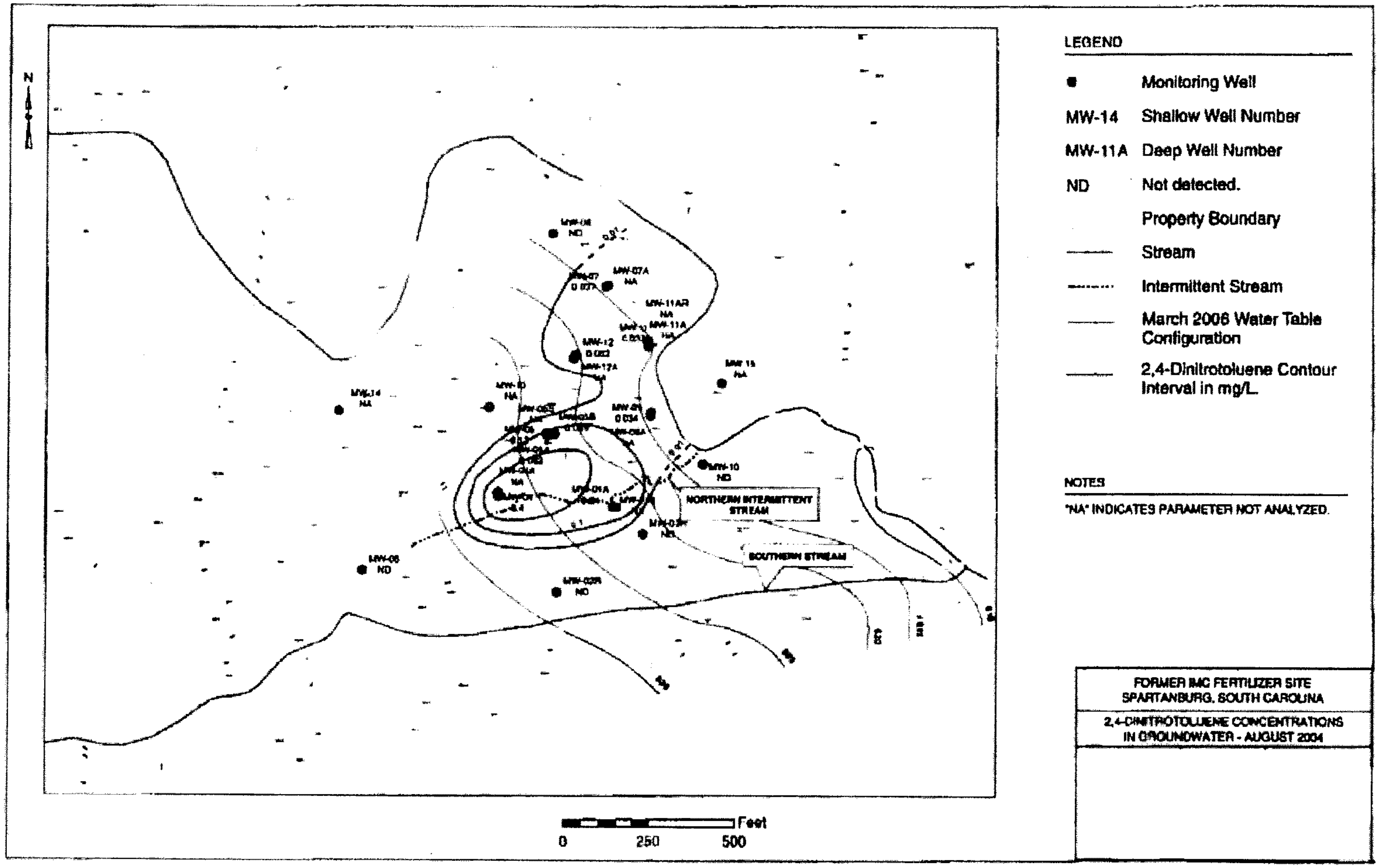

N
NORTHERN INTERMITTENT STREAM
SOUTHERN STREAM
LEGEND
Monitoring Well
MW-14 Shallow Well Number
MW-11A Deep Well Number
ND Not detected.
Property Boundary
Stream
Intermittent Stream
March 2006 Water Table Configuration
2,4-Dinitrotoluene Contour Interval in mg/L.
NOTES
"NA" INDICATES PARAMETER NOT ANALYZED.
FORMER IMC FERTILIZER SITE SPARTANBURG, SOUTH CAROLINA
2,4-DINITROTOLUENE CONCENTRATIONS IN GROUNDWATER - AUGUST 2004
Feet
0 250 500

Figure 24

5.6 Nature and Extent of Surface Water Contamination

Discussion of surface water quality is divided into two separate areas; (1) the surface waters of Fairforest Creek, and (2) the Southern Stream that runs along the boundary of the site adjacent to the Arkwright Dump Site. COPCs for each area are different. Surface water sampling locations are shown on **Figure 25**.

Fairforest Creek

Background values for Fairforest Creek are those surface water concentrations detected at upstream sampling points SW-01 and SW-02. Manganese was the only COPC for Fairforest Creek surface water. Manganese does not have a surface water quality criterion. Most surface water samples were above the background level of 0.058 mg/L, ranging from 0.058 mg/L at SW- 04 to 0.87 mg/L at SW-06. Because lead exceeded SC DHEC Surface Water Criterion at each surface water sampling location, including background locations, lead was included in this evaluation. There was no identifiable trend detected. Surface water results indicate the absence of a significant impact to water quality from discharge of site ground waters to Fairforest Creek.

Southern Stream

The upstream background sampling location is ESI-IM-12-SW. Each of the downstream sample locations are near the northern edge of the Arkwright Dump. The results for COPCs determined for surface waters in this stream were compared to background levels. COPCs for this stream are manganese, iron and bis(2-ethylhexyl)phthalate. Manganese in samples downstream of the background sample ranged from 0.11 to 0.14 mg/L exceeding the background level of 0.064 mg/L. Iron in samples downstream of the background sample ranged from 0.6 to 1.1 mg/L exceeding the background level of 0.064 mg/L. There is no surface water criterion for iron. One detection of bis(2-ethylhexyl)phthalate was made downstream of the non-detect background sample. ESI-IM-13-SW exhibited a concentration of 0.017 mg/L. This location is near the northern edge of the Arkwright Dump. Inasmuch as the southern stream receives the vast majority of its flow from run-off from the Arkwright Dump, elevated concentrations of COPCs are likely attributable to that source.

5.7 Nature and Extent of Sediment Contamination

Fairforest Creek Sediment

Sediment samples were obtained at locations coincident with surface water samples. Results were compared to background concentrations. Results for COPCs in the Creek sediments were compared to background at SD-01 and SD-02. Concentrations for

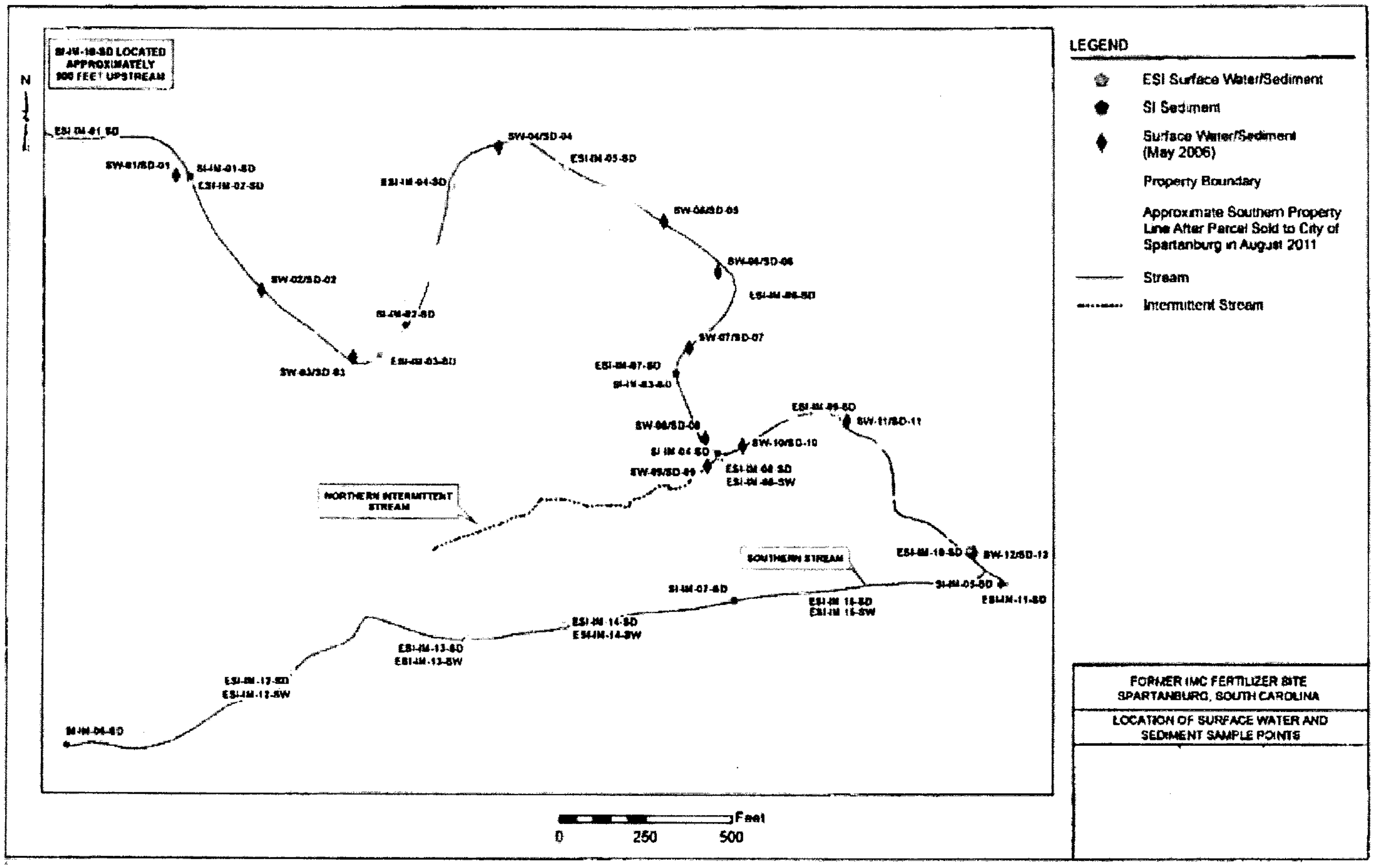

LEGEND
ESI Surface Water/Sediment
SI Sediment
Surface Water/Sediment (May 2006)
Property Boundary
Approximate Southern Property Line After Parcel Sold to City of Spartanburg in August 2011
Stream
Intermittent Stream
FORMER IMC FERTILIZER SITE
SPARTANBURG, SOUTH CAROLINA
LOCATION OF SURFACE WATER AND SEDIMENT SAMPLE POINTS
N
SOUTHERN STREAM
Feet
0
250
500

Figure 25

arsenic ranged from 0.67 to 1.8 mg/kg at downstream sampling locations. The upstream background level of arsenic in Fairforest Creek sediment is 0.83 mg/kg. The highest concentration was detected in sediment just downstream of the confluence of the northern intermittent stream with Fairforest Creek at SD-10. Downstream concentrations for lead ranged from 4.4 to 13 mg/kg compared to the background of 4.0 mg/kg. Downstream concentrations of manganese ranged from 38 to 62 mg/kg bracketing the background concentration of 49 mg/kg in stream sediments. Nitrates were detected in only two downstream sediment samples (SD-07 and SD-10) at concentrations of 4.5 and 2.1 mg/kg, respectively, and as compared to a background concentration of <5.4 mg/kg.

Southern Stream Sediments

Sediment samples were obtained in the southern stream and the results were compared to upstream background concentrations. Benzo(a)pyrene was retained as the COPC in sediments in this stream; concentrations were highest in the background sample at 0.25 mg/kg.

5.8 Non-Time Critical Removal Action (NTCRA)

On September 30, 2009, a NTCRA memo was issued for the Site. The application of a NTCRA to specifically address contaminated soil and process residuals at the site in lieu of a remedial action (RA) to address affected media at the Site had the potential to reduce the duration and administrative costs of the response action. EPA determined that the NTCRA would be protective of human health and the environment and would be consistent with any future RA. The NTCRA did not address groundwater, surface water, or sediment at the Site. A Proposed Action Fact Sheet was issued in May 2009 and was the subject of two public meetings held in Spartanburg, SC on June 11, 2009 and July 23, 2009. Soil cleanup levels were developed for the NTCRA. These levels and the basis for them are presented in **Table 1** below.

Table 1 – NTCRA Soil Cleanup Levels

CONSTITUENT	CLEANUP LEVEL (mg/kg)	BASIS FOR CLEANUP LEVEL
2,4-DNT	0.48	Contract Required Quantitation Limit (CRQL)
2,6-DNT	0.48	CRQL
PCBs	5.9	Background concentration
Arsenic	12	Hazard Index (HI) =1
Lead	500	OSWER Directive 9355.4-12 for industrial use
Fluoride	260	Background concentration

NTCRA activities were initiated in June 2010 and were completed in April 2011. The activities performed as part of the NTCRA reduced available exposure/migration pathways and reduced concentrations of Site COPCs. The NTCRA activities addressed three process residual areas, three small areas of material consistent with process residuals, and four affected soil areas. These 10 areas are shown on **Figure 26** and include the following:

- Three process residual areas referred to as the Southwest Process Residual (SWPR), Southeast Process Residual (SEPR), and Northeast Process Residual (NEPR) areas located south and east of the former manufacturing building area. Each of these areas was covered with clean overburden.

- One area of material consistent with process residuals was present southeast of the three process residual areas referenced above in an area referred to as the "Geophysical Anomaly." Two additional areas were located near the southeast corner of the fence area surrounding the former manufacturing building area.

- Four areas of soil were identified as having arsenic or polychlorinated biphenyl (PCB) concentrations greater than the cleanup levels. These areas are identified as affected soil areas AS-A through AS-D.

Additionally, the following materials were also addressed as part of the NTCRA activities **(Figure 27)**:

- The miscellaneous materials (construction debris) located in a small area south of the NEPR area.

- A small below-ground explosives bunker that was located near the eastern end of the facility.

- Remnants of a steel tank which appeared to be a former process vessel.

- Treated timbers and debris that were previously disposed of on the ridge northeast of the Former Sulfuric Acid Plant.

The NTCRA activities included excavation of process residuals, materials consistent with process residuals, affected soil, and miscellaneous materials; confirmation testing of underlying soils; transportation of excavated impacted materials for disposal at the Republic Landfill in Union County, SC; and site restoration.

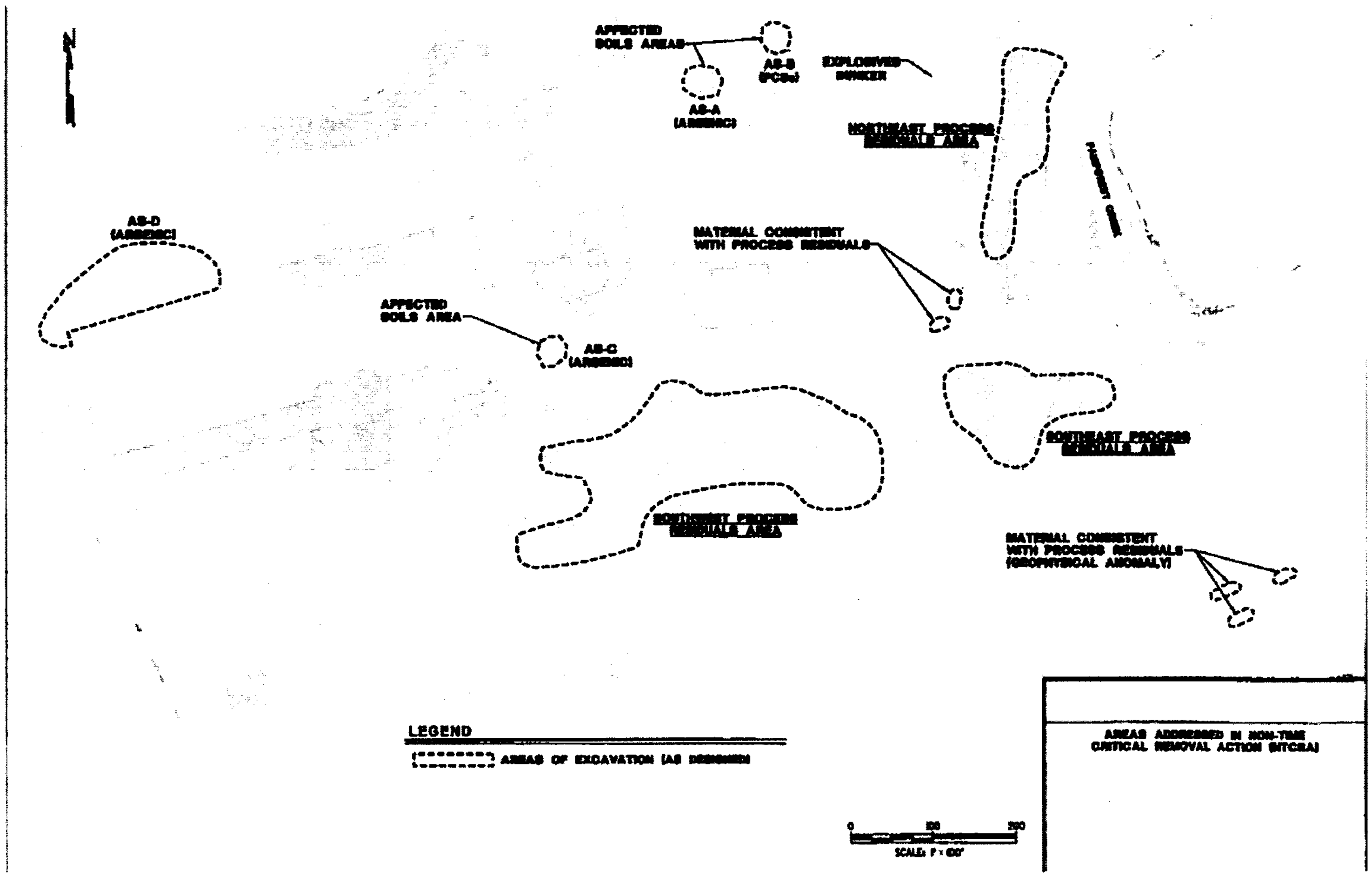

AFFECTED SOILS AREAS
AS-B (PCBs)
AS-A (ARSENIC)
EXPLOSIVES BUNKER
NORTHEAST PROCESS RESIDUALS AREA
AS-D (ARSENIC)
MATERIAL CONSISTENT WITH PROCESS RESIDUALS
AFFECTED SOILS AREA
AS-C (ARSENIC)
SOUTHEAST PROCESS RESIDUALS AREA
SOUTHWEST PROCESS RESIDUALS AREA
MATERIAL CONSISTENT WITH PROCESS RESIDUALS (GEOPHYSICAL ANOMALY)
LEGEND
AREAS OF EXCAVATION (AS DESIGNED)
AREAS ADDRESSED IN NON-TIME CRITICAL REMOVAL ACTION (NTCRA)
0 100 200

Figure 26

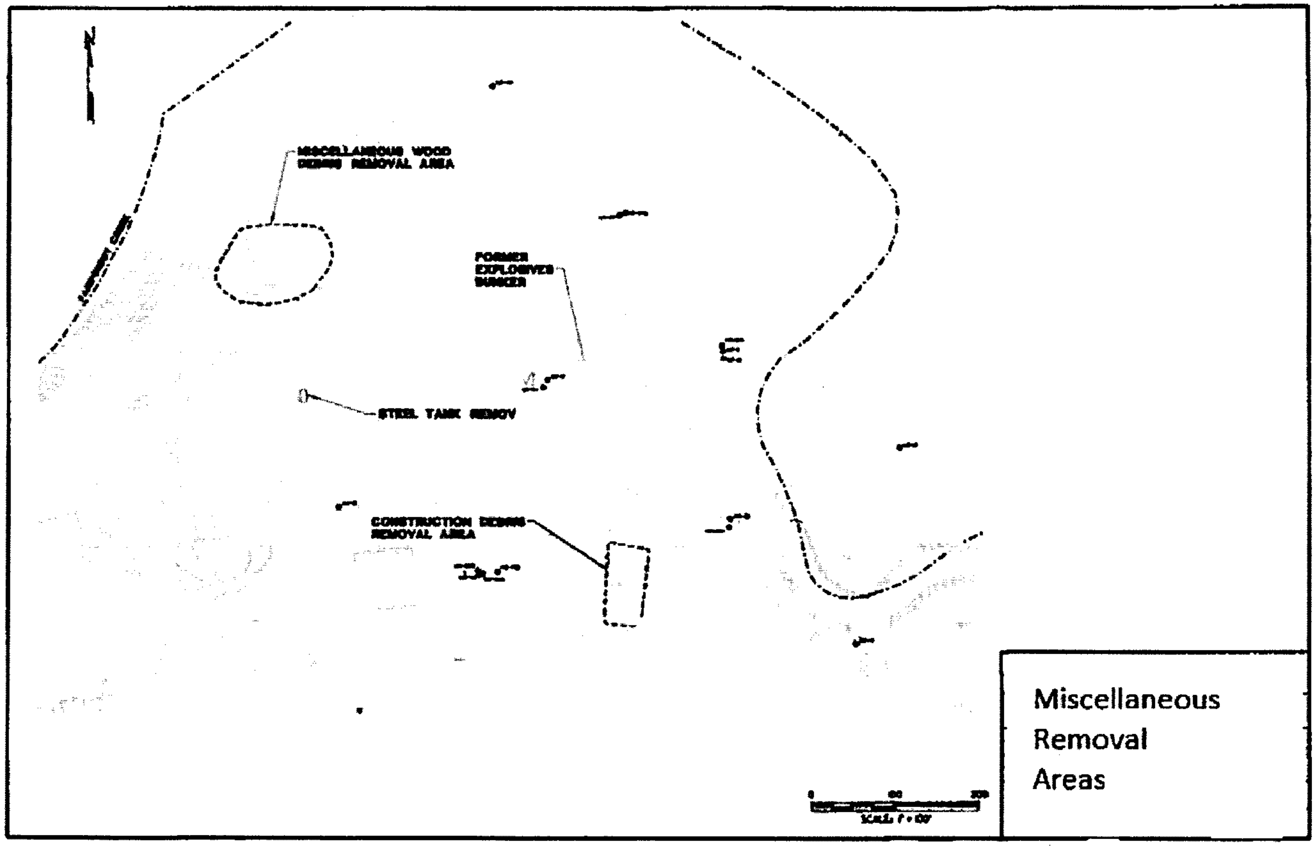

MISCELLANEOUS WOOD
DEBRIS REMOVAL AREA
FORMER
EXPLOSIVES
BUNKER
STEEL TANK REMOV
CONSTRUCTION DEBRIS
REMOVAL AREA
Miscellaneous
Removal
Areas

Figure 27

The initial extent of the excavations was based on analytical and soil boring data generated during the RI. In areas where process residuals and material consistent with process residuals were being removed, the excavations once initiated were continued until the visual extent of materials were removed. After initial excavations were complete, confirmation soils samples were collected from the bottom and side walls of each excavation to determine if cleanup levels had been met **(Figure 28)**.

The total volume of clean overburden and process residuals/affected soil removed from each area is summarized in **Table 2** below:

EXCAVATION AREA	OVERBURDEN REMOVAL QUANTITIES (cubic yards)	PROCESS RESIDUAL/AFFECTED-SOIL REMOVAL QUANTITIES (cubic yards)
AS-A	0	275
AS-B	0	60
AS-C	0	115
AS-D	0	1,285
Anomaly Area	0	1,000
SEPR	1,450	14,300
SWPR	5,100	3,375
NEPR	475	1,300
Total	7,025	21,710

A small below-ground explosives bunker was located near the eastern end of the facility. An explosives expert opened and inspected the bunker. The bunker was found to be empty with no residue or miscellaneous explosive components. It was determined that the bunker was safe for demolition. The explosives bunker was removed and demolished on June 22, 2010.

As part of the NTCRA activities, miscellaneous materials were removed from the site for disposal. These materials consisted of the following: remnants of a steel tank, possibly a former process vessel, that was located near the Former Sulfuric Acid Plant; timbers previously used to support a rail track to the former facility that were located on the ridge to the northeast of the Former Sulfuric Acid Plant; and construction debris located between the NEPR and SWPR areas.

Excavated process residuals and affected soil (27,272.18 tons (1,243 truckloads)),and miscellaneous materials/construction debris (2,632.54 tons (130 truckloads)) were transported by truck to the Republic Landfill in Union County, SC for disposal.

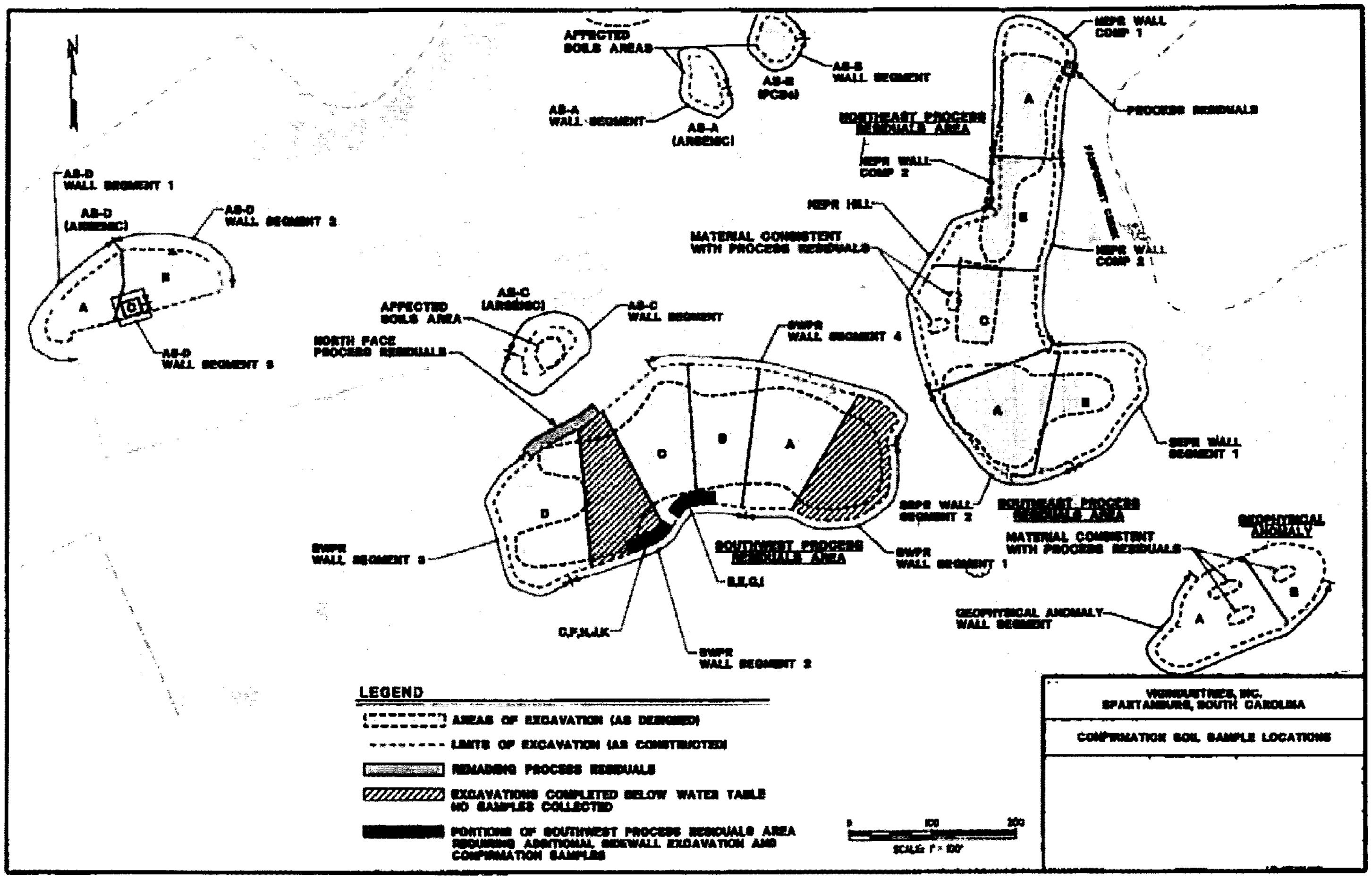

LEGEND
AREAS OF EXCAVATION (AS DESIGNED)
LIMITS OF EXCAVATION (AS CONSTRUCTED)
REMAINING PROCESS RESIDUALS
EXCAVATIONS COMPLETED BELOW WATER TABLE NO SAMPLES COLLECTED
SOUTHWEST PROCESS RESIDUALS AREA
SOUTHEAST PROCESS RESIDUALS AREA
NORTHEAST PROCESS RESIDUALS AREA
MATERIAL CONSISTENT WITH PROCESS RESIDUALS
AFFECTED SOILS AREAS
NORTH FACE PROCESS RESIDUALS
GEOPHYSICAL ANOMALY
CONFIRMATION SOIL SAMPLE LOCATIONS
SPARTANBURG, SOUTH CAROLINA

Figure 28

Following excavation of the process residuals from the Process Residuals areas, a pH neutralizing/buffering agent was placed in the bottom of the excavations prior to site restoration activities. Crushed limestone with aggregate diameters ranging from 1 to 2 inches was selected for use as the pH neutralization/ buffering agent. A 6-inch thick layer of crushed limestone was placed in the bottom of the excavations created by the removal of process residuals. Approximately 2,875 tons of limestone was placed as part of the NTCRA restoration activities.

5.8 Post-NTCRA Groundwater Monitoring

A groundwater monitoring program was instituted after the NTCRA. A baseline monitoring event was conducted in June 2010 prior to the removal. The removal action was completed in February 2011 and the initial post-removal monitoring event was conducted in May 2011. Five monitoring events were conducted between May 2011 and May 2013.

As illustrated previously, with the exception of nitrate at MW-14, the specific areas of groundwater contaminants were generally within the Process Residuals Area and the Northeast Area where pH was less than 5.0 s.u. The constituent with the most extensive groundwater area was fluoride. Prior to the NTCRA, there appeared to be two areas on the site that acted as sources of low pH to groundwater; the former Process Residuals and the Former Sulfuric Acid Plant areas.

Post-NTCRA groundwater monitoring results **(Table 3)** reflect notable improvements in groundwater quality in the Process Residuals Area. Concentrations for most COCs declined compared to pre-NTCRA concentrations while pH values increased. Prior to the NTCRA, arsenic, cadmium, lead, and nitrate concentrations in groundwater in the vicinity of the Process Residuals Area were greater than their respective MCLs. Concentrations in groundwater in this area are now below the MCLs. While beryllium and fluoride concentrations in groundwater at the Process Residuals Area remain above MCLs, both constituents exhibit decreases in concentration since completion of the NTCRA.

Post-NTCRA groundwater monitoring results demonstrate that the NTCRA activities, which included removal of process residuals and affected soil, and addition of limestone to the bottom of the resulting excavations prior to backfilling, has resulted in a positive impact on groundwater quality at the Process Residual Area. No further source removal action is planned for this area; performance groundwater monitoring will continue.

Groundwater in the Northeast Area of the Site continues to have a number of COCs detected at concentrations greater than MCLs/action levels and relatively low pH

Table 3
Groundwater Trends (PPB)

CONSTITUENT	PROCESS RESIDUAL AREA		NORTHEAST AREA	
	RI (2004)	POST-NTCRA (11/2012)	RI (2004)	POST-NTCRA (11/2012)
Groundwater Conc. > MCL/Action Level				
Arsenic	46	ND	3.9	6.2
Beryllium	37	24.2	76	92.8
Cadmium	13	0.47	31	17.6
Fluoride	610,000	74,000	200,000	211,000
Lead	180	4.8	120	47.2
Nitrate	48,000	4,800	98,000	142,000
Selenium	51	ND	110	ND
Thallium	3	ND	5.6	ND
Risk Assessment Groundwater COC (Risk > 10-6 or HI >1.0)				
Aluminum	330,000	55,900	350,000	252,000
Cobalt	480	71.4	81	71.9
Manganese	30,000	6,730	24,000	17,300
Nickel	230	134	37	342
Vanadium	280	64.4	57	142
Zinc	2,700	512	2,600	2,190
2,4-DNT	8,300	1,310	120	79.2
2,6-DNT	170	ND	32	51.6

values. While some constituent concentrations have fluctuated up and down slightly, overall concentrations have remained relatively stable since completion of the Focused Removal Action completed in 2002 and the NTCRA completed in 2011. One exception is nitrate which has exhibited recent increasing trends in downgradient monitoring wells MW-7 and MW-8.

In October 2013, an evaluation was conducted to determine the source of the low pH in the Northeast Area groundwater. The evaluation included collecting subsurface soil samples, analyzing for soil pH, and conducting bench scale tests for in situ neutralization of the acid. Soil samples were collected from 33 soil borings **(Figure 29)**. Continuous soil samples were collected from ground surface to either tool refusal or the water table. Prior to this sampling event, it was anticipated that low pH values would be found in soils in the immediate vicinity of the Former Sulfuric Acid Plant operational area with the lowest pH values found in the shallow soils (less than eight feet in depth). The pH values in affected areas actually tended to decrease with depth with the lowest values found greater than 10 feet bls with low pH soils generally extending vertically to the groundwater table. Borings with low-pH soils (less than 3.5 s.u.) were typically found in the eastern portions of the Former Sulfuric Acid Plant area. The areal extent of low-pH soil, is about 1.3 acres, and the soils with low pH values are typically found at approximately 10 to 25 feet bls.

Bench scale tests were conducted to evaluate options for neutralizing the soil pH and groundwater pH. Bench tests for soil included elutriation with deionized water and neutralization with three chemical solutions: magnesium oxide, 1 M sodium bicarbonate, and 0.5 M sodium bicarbonate-disodium lactate. The results indicated that the soil required approximately 10 mmoles of sodium carbonate per kilogram (wet weight) of soil to raise the pH above 6 s.u. or a 0.1 percent dose, based on weight. Bench scale tests (titrations) for direct groundwater neutralization were conducted using sodium hydroxide and sodium carbonate. The results indicated that large amounts of gelatinous solids were generated that can be expected to clog soil pores if in situ groundwater treatment were conducted at the site. Additives such as citrate can prevent the formation of solids, but the effect is eventually reversed.

5.9 CONCEPTUAL SITE MODEL

The Site conceptual model is illustrated in **Figure 30**. The figure depicts sources, exposure pathways, and exposure points as determined during the RI. The figure also indicates which exposure pathways had risk/hazard levels exceeding EPA's acceptable range.

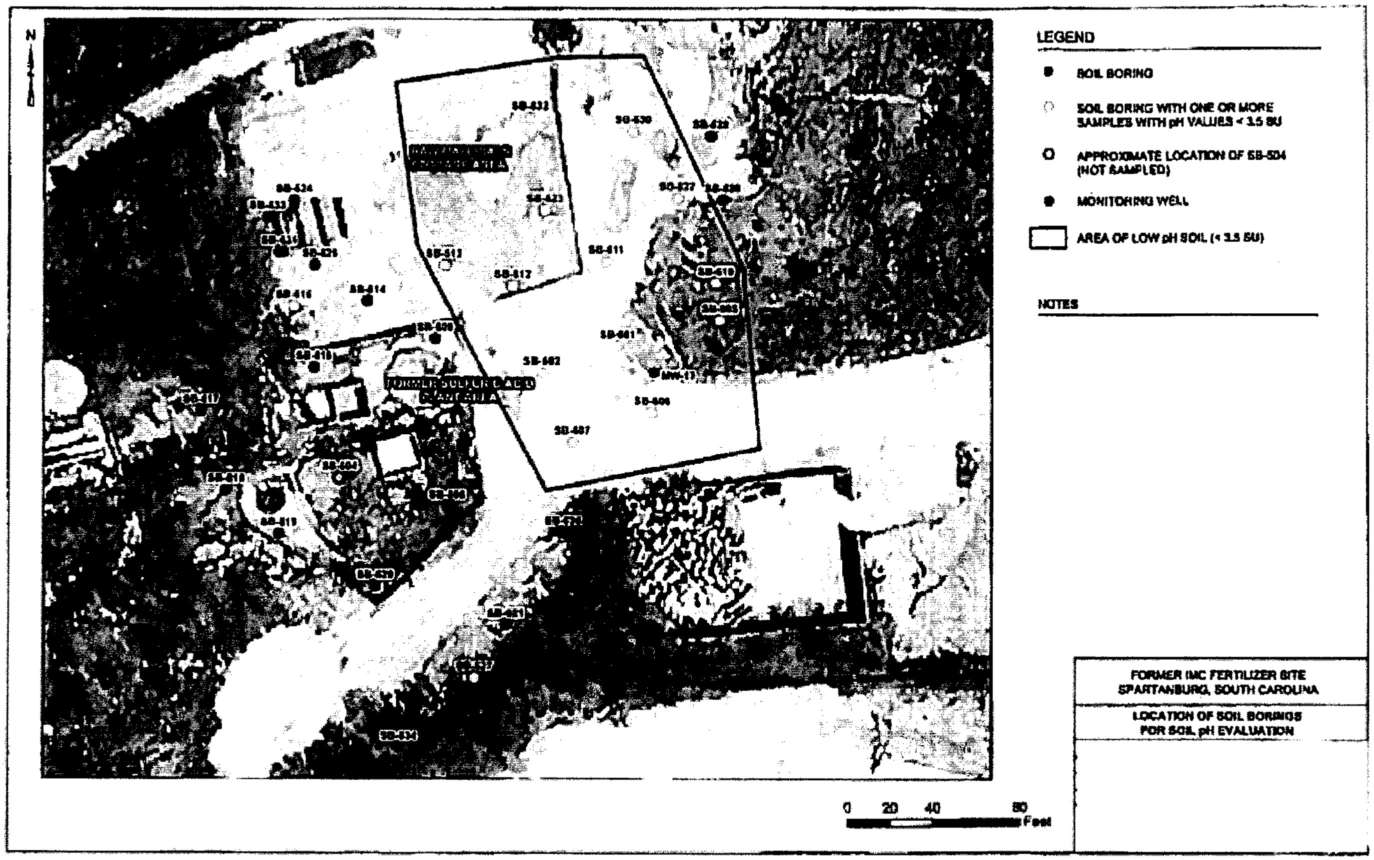

N
LEGEND
SOIL BORING
SOIL BORING WITH ONE OR MORE SAMPLES WITH pH VALUES < 3.5 SU
APPROXIMATE LOCATION OF SB-504 (NOT SAMPLED)
MONITORING WELL
AREA OF LOW pH SOIL (< 3.5 SU)
NOTES
FORMER IMC FERTILIZER SITE SPARTANBURG, SOUTH CAROLINA
LOCATION OF SOIL BORINGS FOR SOIL pH EVALUATION
0 20 40 80 Feet

Figure 29

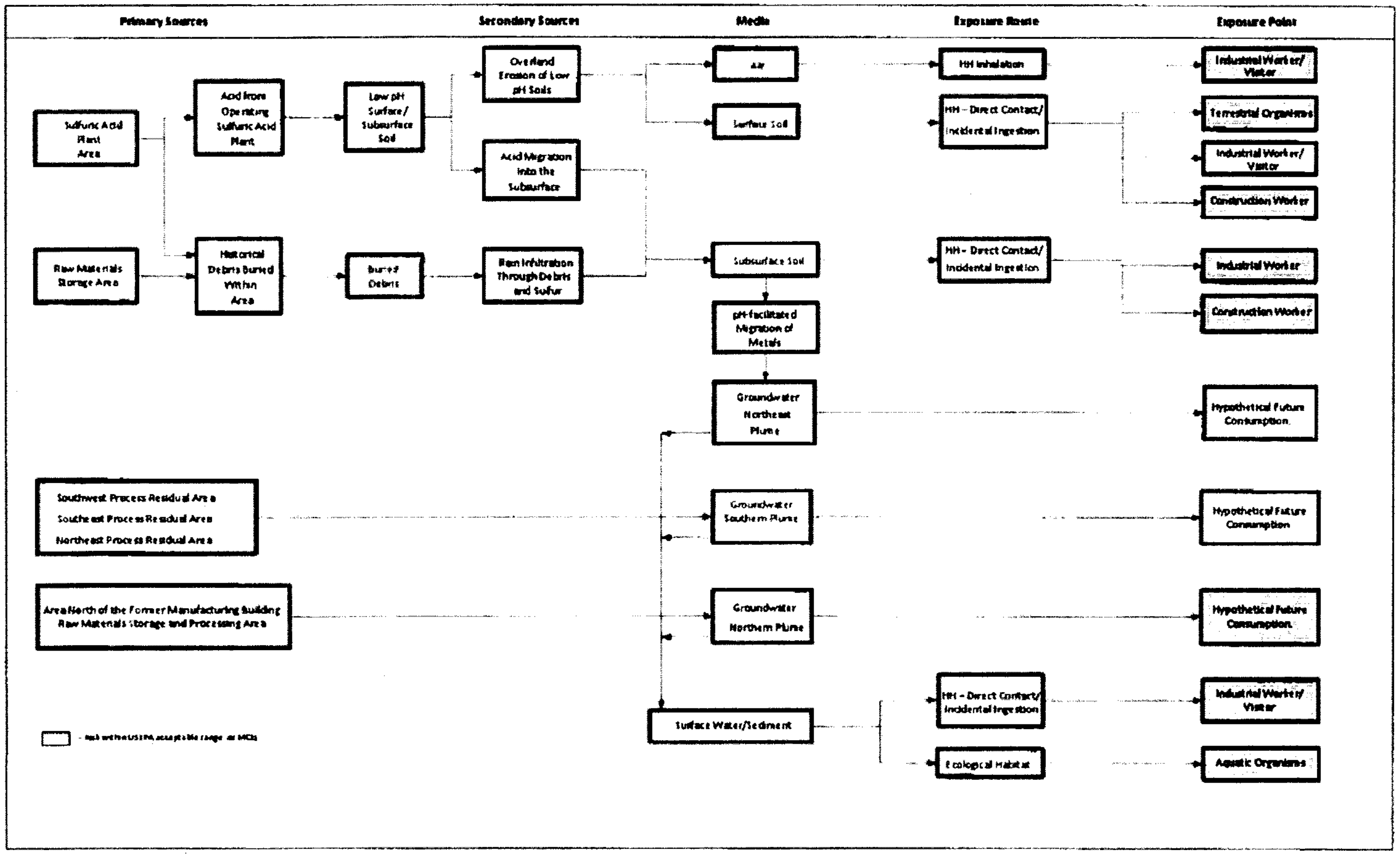


Figure 30 - Site Conceptual Model

6.0 CURRENT AND POTENTIAL LAND AND RESOURCE USES

The IMC Site is presently unoccupied and no intact buildings remain on site. Remnants of production structures remain; sections of concrete walls and floors, and railroad ties. The remainder of the Site is heavily vegetated with trees and other natural vegetation. Industrial properties in the vicinity include a Mt. Vernon Mills facility to the northwest, an active Rhodia Chemical Company facility to the southwest, and the inactive Arkwright Mills property to the northwest (**Figure 2**). The land uses in the vicinity of the Site include industrial, residential, and undeveloped properties.

Public water is available in the area. Spartanburg Water System uses surface water from three lakes within Spartanburg County: Lake William C. Bowen, Municipal Reservoir #1, and Lake Taylor H. Blalock. All South Carolina groundwater is classified as GB as defined in R.61-58, State Primary Drinking Water Regulations.

The site owner, in partnership with the local group, ReGenesis is exploring reuse options that will benefit the community and will be compatible with the remediation and operation and maintenance of the Site.

7.0 SUMMARY OF SITE RISKS

This section of the ROD provides a summary of the IMC Site's human health and environmental risks. A Baseline Human Health Risk Assessment (HHRA) for the Site was completed in April 2007 and updated in July 2014. The HHRA estimates the human health risks that the IMC Site could pose if no actions were taken. It is one of the factors EPA considers in deciding whether to take actions at a site. The risk assessment also identifies the contaminants and exposure pathways that need to be addressed by the remedial action. A Screening Level Ecological Risk Assessment for the IMC Site was completed in April 2007.

7.1 Summary of Human Health Risk Assessment

The HHRA involves the following four steps: 1) data evaluation, to identify site-related contaminants of concern (COCs); 2) exposure assessment, to determine potential exposure pathways and quantify the magnitude of potential exposure; 3) toxicity assessment, to determine types of effects associated with exposures; and 4) risk characterization, to quantify cancer risks and non-cancer health hazards associated with specific exposures at the Site. The complete HHRA can be found in the RI which is included in the Administrative Record.

7.1.1 Identification of Contaminants of Concern

COPCs are those constituents, identified through a conservative toxicity screening process, which are most likely to contribute to an unacceptable human health and ecological risk, if any exists. The selection of site-specific human health COPCs was conducted consistent with *Supplemental Guidance to Risk Assessment Guidance for Superfund (RAGS): Region 4 Bulletins, Human Health Risk Assessment* (USEPA, 200Gb). The identification of site-specific ecological COPCs was performed and documented in the *Screening Level Ecological Risk Assessment* and approved in the *Refinement of Ecological COPCs* submittal.

The following COPCs were identified for the IMC Site:

- **Surface Soil** - 2,4-DNT, Acetophenone, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Dieldrin, Heptachlor epoxide, Dioxin/furans, PCBs, Aluminum, Antimony, Arsenic, Cadmium, Cyanide, Fluoride, Iron, Lead, Mercury, Nitrate-N, Thallium, and Vanadium.

- **Subsurface Soil** - Benzo(a)anthracene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, 2,4-DNT, Aldrin, Dieldrin, Dioxin/furans, PCBs, Aluminum, Arsenic, Fluoride, Lead, Nitrate-N, and Vanadium.

- **Sediment** – Acetophenone, Benzo(a)pyrene, Arsenic, Iron, Lead, Manganese, Nitrate-N, and Vanadium.

- **Surface Water** - bis(2-Ethylhexyl)phthalate, Iron, and Manganese.

- **Groundwater** - alpha-BHC, Aluminum, beta-BHC, Arsenic, Benzene, Beryllium, bis(2-Ethylhexyl)phthalate, Cadmium, Chloroform, Chromium, Cyanide, Cobalt, 1,3-Dinitrobenzene, 2,4-DNT, Copper, 2,6-DNT, 2-Methylnaphthalene, Fluoride, Naphthalene, Iron, 2-Nitrotoluene, Lead, 4-Nitrotoluene, Manganese, Nickel, Tetrachloroethene , 2,4,6-Trinitrotoluene, Nitrate-N, Vinyl Chloride, Selenium, Xylenes, Thallium, Vanadium, and Zinc.

7.1.2 Exposure Assessment

The objective of the exposure assessment is to estimate the type and magnitude of potential exposures to COPCs in environmental media associated with the site. The exposure assessment for the Site follows the guidance in RAGS (EPA, 1989) and addresses the following elements:

- Characterization of the exposure setting
- Identification of migration and exposure pathways
- Quantification of exposure

Characterization of Exposure Setting

As a component of characterizing the exposure setting for the Site, potential human receptors and their expected types of exposure to the COPCs present at the Site were identified for current and hypothetical future land use scenarios. These potential human receptors represent those segments of the population most likely to come into contact with the COPCs present in environmental media at the Site.

Given the location of the Site, human populations that may potentially be exposed to COPCs under the current land use scenario are limited to construction workers. Fencing and accessibility limitations limit trespasser exposure to surface soil, sediment, and surface water in the area. However, to maintain conservative evaluations in this baseline human health risk assessment, a trespasser scenario is evaluated for the Site under current land use conditions.

Under a hypothetical future land use scenario, which could involve industrial or commercial development of the Site, potential exposure to COPCs is limited to industrial worker exposure to surface soils and commercial worker exposure to surface soils and surface water in Fairforest Creek.

Shallow groundwater in the vicinity of the Site is not currently used, and is not reasonably expected to be used, as a potable water source. Therefore, potential groundwater ingestion pathways are considered incomplete for all receptors under consideration for current land uses, and were not quantitatively evaluated in the risk assessment for those receptors.

The baseline risk assessment includes an evaluation of residential exposures under a hypothetical future land use scenario. The hypothetical residential scenario assumes incidental exposure to soils and surface water and ingestion exposure to groundwater through installation and use of a potable water supply well into the water table aquifer below the site rather than utilizing the available city water supply.

Identification of Migration and Exposure Pathways

The conceptual site model **(Figure 30)** reflects historical releases from manufacturing process areas and wastewater ponds, the COPCs for each affected environmental medium, and the migration and transport potential of this constituent to potential receptors. An exposure pathway is the means by which a constituent moves from a source to a receptor. A completed exposure pathway has the following elements:

- Constituent source
- Mechanism for constituent release and environmental transport medium
- Feasible route of potential exposure

Completed exposure pathways are the means by which potentially exposed populations (receptors) come into contact with site-related COPCs. Site-specific physical and operational characteristics contribute to those segments of the human population that have realistic probabilities of exposure to the site. Access to the Site is controlled by security fencing limiting potential current human receptors to construction workers and illegal trespassers. Evaluation of hypothetical future exposure scenarios was expanded to include a wider scope of potential human receptors however unlikely.

The completed exposure pathways evaluated under current land use scenarios for potential human receptors at the site are as follows:

- Construction worker exposure to COPCs in surface and subsurface soil, drainage feature sediments, and surface water
- Adolescent trespasser exposure to COPCs in surface soil, intermittent drainage sediment, and surface water

The exposure pathways evaluated for the human receptor under hypothetical future land use scenarios at the site are as follows:

- Industrial worker exposure to surface and subsurface soil
- Commercial worker exposure to surface soil and surface water
- Adult resident exposure to COPCs in surface soil, surface water, and groundwater

The exposure routes associated with the potentially completed exposure pathways evaluated for the Site are as follows:

Current Land Use

Construction Worker

- Incidental ingestion of surface soil, subsurface soil, sediment, and surface water
- Dermal contact with surface soil, subsurface soil, sediment, and surface water
- Particulate inhalation of surface soil and subsurface soil

Adolescent Trespasser
- Incidental ingestion of surface soil, sediment, and surface water
- Dermal contact with surface soil, sediment, and surface water
- Particulate inhalation of surface soil

Future Land Use

Industrial Worker
- Incidental ingestion of surface and subsurface soil
- Dermal contact with surface and subsurface soil
- Particulate inhalation of surface and subsurface soil

Commercial Worker
- Incidental ingestion of surface soil and surface water
- Dermal contact with surface soil and surface water
- Particulate inhalation of surface soil

Resident
- Incidental ingestion of surface soil and surface water
- Dermal contact with surface soil and surface water
- Particulate inhalation of surface soil
- Ingestion of groundwater as a primary drinking water source

The potential exposure to site-related COPCs for each receptor is represented by a chronic daily intake (CDI). The CDI for an individual receptor is estimated from the exposure point concentration of each COPC in each environmental medium. Consistent with Region 4 Supplemental Guidance (USEPA, 2000), the exposure point concentrations **(Table 4)** used for estimating CDIs are the lesser of the maximum concentration for each COPC or the 95 percent upper confidence limit (95% UCL) of the mean concentration.

7.1.3 Toxicity Assessment

The toxicity assessment identifies the potential effects that are generally associated with exposure to a given chemical. EPA typically evaluates two types of toxic effects: carcinogenic effects and non-carcinogenic effects. To quantify carcinogenic effects, the EPA has derived slope factors (SFs) for those chemicals found to cause a dose-related, statistically significant increase in tumor incidence in an exposed population relative to the incidence of tumors observed in an unexposed population. These dose-related incidence rates are usually determined in a laboratory study. SFs are typically developed based on oral toxicity studies and are reported as risk per dose in units of inverse milligrams per kilogram body weight per day [$(mg/kg\text{-}day)^{-1}$]. The SFs are used

Table 4 – Exposure Point Concentrations

ENVIRONMENTAL MEDIA	COPC	MAXIMUM OBSERVED CONCENTRATION	CALCULATED 95% UCL	EXPOSURE POINT [3,4] CONCENTRATION
Surface Soil (mg/kg)	Aluminum	53,000	26,186	26,186
	Antimony	4	2.5	2.5
	Arsenic	16	6	6
	Cadmium	3.5	1.35	1.35
	Cyanide	0.96	0.96	0.96
	Iron	76,000	37,749	37,749
	Lead	990	254	254
	Mercury	0.4	0.18	0.18
	Thallium	0.83	0.4	0.4
	Vanadium	180	85	85
	Fluoride	150	102	102
	Nitrate	5.3	3	3
	2,4-Dinitrotoluene	ND	ND	ND
	Acetophenone	ND	ND	ND
	Benzo(a)anthracene	2.3	0.47	0.47
	Benzo(a)pyrene	2.8	0.47	0.47
	Benzo(b)fluoranthene	2.8	0.55	0.55
	Dibenzo(a,h)anthracene	0.49	0.17	0.17
	Indeno(1,2,3-cd)pyrene	1.2	0.59	0.59
	Dieldrin	0.061	0.013	0.013
	Heptachlor epoxide	0.0086	0.002	0.002
	Aroclor-1254	1.5	0.28	0.28
	Aroclor-1260	0.4	0.08	0.08
	Dioxins/Furans(WHO)	0.0002008	0.000049	0.000049

ENVIRONMENTAL MEDIA	COPC	MAXIMUM OBSERVED CONCENTRATION	CALCULATED 95% UCL	EXPOSURE POINT [3,4] CONCENTRATION
Subsurface Soil (mg/kg)	Aluminum	60,000	28,866	28,866
	Arsenic	64	8.7	8.7
	Lead	780	133	133
	Vanadium	230	90	90
	Fluoride	2,700	393	393
	Nitrate	59	22	22
	Benzo(a)pyrene	1	0.10	0.10
	Benzo(a)anthracene	4	0.13	0.13
	Dibenzo(a,h)anthracene	0.245	0.23	0.23
	Aldrin	0.45	0.017	0.017
	Dieldrin	0.32	0.028	0.028
	Aroclor-1254	12	0.44	0.44
	Aroclor-1260	3.7	0.22	0.22
	Dioxins/Furans(WHO)	0.0001	0.0001	0.0001
Groundwater (mg/L)	Alpha-BHC	0.000056	0.000056	0.000056
	beta-BHC	0.000091	0.000038	0.000038
	Benzene	0.059	0.029	0.029
	Chlorform	0.00079	0.00058	0.00058
	2-Nitrotoluene	0.0023	0.0023	0.0023
	4-Nitrotoluene	0.0012	0.0012	0.0012
	2,4-Dinitrotoluene	1.73	0.403	0.403
	2,6-Dinitrotoluene	0.0516	0.00707	0.00707
	1,3-Dinitrobenzene	0.0017	0.0017	0.0017
	2,4,6-Trinitrotoluene	0.0023	0.0023	0.0023
	Naphthalene	0.0031	0.0031	0.0031
	2-Methylnaphthalene	0.0044	0.0044	0.0044

ENVIRONMENTAL MEDIA	COPC	MAXIMUM OBSERVED CONCENTRATION	CALCULATED 95% UCL	EXPOSURE POINT [a,b] CONCENTRATION
Groundwater (con't) (mg/L)	Tetrachloroethene	0.0048	0.0028	0.0028
	Vinyl Chloride	0.0023	0.00077	0.00077
	Xylenes	0.064	0.017	0.017
	Aluminum	257	97.95	97.95
	Arsenic	0.0943	0.0046	0.0046
	Beryllium	0.0928	0.0263	0.0263
	Cadmium	0.0186	0.00979	0.00979
	Chromium	0.079	0.016	0.016
	Cobalt	0.741	0.35	0.35
	Copper	0.26	0.15	0.15
	Cyanide	0.013	0.013	0.013
	Fluoride	211	93.34	93.34
	Iron	58	40	40
	Lead	0.0472	0.0132	0.0132
	Manganese	18.2	8.952	8.952
	Nickel	1.51	0.398	0.398
	Nitrate-N	142	63.9	63.9
	Selenium	ND	ND	ND
	Thallium	0.0775	0.00341	0.00341
	Vanadium	0.142	0.0345	0.0345
	Zinc	2.19	0.85	0.85

Notes: Exposure point concentrations updated to reflect conditions following completion of the NTCRA.
For groundwater, red values are updated; black values are for constituents that were not analyzed post-NTCRA.

to quantify the potential risk of cancer associated with a given exposure. To quantify non-carcinogenic effects, EPA has derived reference doses (RfDs) that represent a threshold of toxicity. RfDs are expressed in units of mg/kg-day and represent "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (EPA, 1989).

7.1.4 Risk Characterization

In the baseline risk characterization, the results of the toxicity and exposure assessments are summarized and integrated into quantitative and qualitative expressions of potential risk for carcinogenic compounds and into a HI for noncarcinogenic compounds. According to RAGS (USEPA, 1989), the risk characterization is complete only when the numerical expressions of potential risk are accompanied by explanatory text interpreting and qualifying the results. In addition, the baseline risk characterization presents RME and average/CTE to baseline site conditions in the absence of additional site controls or remediation. **Tables 5 through 18** provide a summary of the risk calculations based on RME and CTE.

The HQ is a quantitative estimate of the potential hazard associated with individual noncarcinogenic compounds. The HQ is the ratio of the intake (COI) for each COPC to the RID for that constituent. HQs for individual COPCs are summed, where appropriate, to calculate the HIs for a pathway. If multiple pathways exist, appropriate pathway HIs are added together to calculate a site HI. A total site HI of less than 1 indicates that no significant hazard is likely, even for sensitive individuals. A HI of greater than 1 indicates that there may be a potential hazard at the Site.

Potential risks for individual constituents are calculated by multiplying the intake (COI: mg/kg-day) by the SF $(mg/kg\text{-}day)^{-1}$ to give a unitless chemical-specific risk. Chemical-specific potential risks that are the result of the same exposure route are summed to give the pathway risk; if multiple pathways exist, appropriate pathway risks are summed resulting in the total carcinogenic risk for a specific receptor population.

The EPA has established the range of 1×10^{-4} to 1×10^{-6} as target maximum limits for potential excess lifetime carcinogenic risks. A risk value of 1×10^{-4} indicates that for every 10,000 persons exposed to the site, an additional one person is estimated to potentially develop cancer in excess of the normal population. USEPA considers those exposure pathways with a potential cumulative risk in excess of 1×10^{-4} to represent an excessive risk to a receptor population (EPA, 1989; EPA, 1998).

Table 5
Summary of Incremental Risk and Hazard Quotients
Construction Worker – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Ingestion				
Inorganics				
Aluminum	NC	0.085	NC	0.022
Antimony	NC	0.020	NC	0.005
Arsenic	4.19E-07	0.065	5.56E-08	0.017
Cadmium	NC	0.004	NC	0.001
Cyanide	NC	0.000	NC	0.000
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	NC	NC	NC
Thallium	NC	NC	NC	NC
Vanadium	NC	0.039	NC	0.010
Fluoride	NC	0.006	NC	0.001
Nitrate	NC	0.000	NC	0.000
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	1.60E-08	NC	2.12E-09	NC
Benzo(a)pyrene	1.60E-07	NC	2.12E-08	NC
Benzo(b)fluoranthene	1.84E-08	NC	2.44E-09	NC
Dibenzo(a,h)anthracene	5.83E-08	NC	7.73E-09	NC
Indeno(1,2,3-cd)pyrene	1.97E-08	NC	2.61E-09	NC
Pesticides/PCBs				
Dieldrin	9.52E-09	0.001	1.26E-09	0.000
Heptachlor epoxide	7.05E-10	0.0004	9.36E-11	0.000
Aroclor-1254	2.61E-08	0.046	3.47E-09	0.012
Aroclor-1260	7.50E-09	NC	9.96E-10	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	3.38E-07	NC	4.49E-08	NC
Total Ingestion	**1.07E-06**	**0.27**	**1.42E-07**	**0.07**

Table 5
Summary of Incremental Risk and Hazard Quotients
Construction Worker – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Dermal				
Inorganics				
Aluminum	NC	0.0003	NC	0.00005
Antimony	NC	0.0006	NC	0.00008
Arsenic	1.73E-09	0.0003	1.27E-10	0.00004
Cadmium	NC	0.0007	NC	0.00011
Cyanide	NC	0.0000	NC	0.00000
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	NC	NC	NC
Thallium	NC	NC	NC	NC
Vanadium	NC	0.0062	NC	0.00091
Fluoride	NC	0.0003	NC	0.00000
Nitrate	NC	0.0000	NC	0.00000
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	6.58E-10	NC	4.83E-11	NC
Benzo(a)pyrene	6.58E-09	NC	4.83E-10	NC
Benzo(b)fluoranthene	7.56E-10	NC	5.55E-11	NC
Dibenzo(a,h)anthracene	2.40E-09	NC	1.76E-10	NC
Indeno(1,2,3-cd)pyrene	8.12E-10	NC	5.96E-11	NC
Pesticides/PCBs				
Dieldrin	3.92E-10	0.00003	2.88E-11	0.00001
Heptachlor epoxide	2.91E-11	0.00002	2.13E-12	0.00000
Aroclor-1254	1.08E-09	0.0019	7.90E-11	0.00028
Aroclor-1260	3.09E-10	NC	2.27E-11	NC
Dixons/Furans				
Dioxins/Furans(WHO)	1.39E-08	NC	1.02E-09	NC
Total Dermal	2.87E-08	0.010	2.11E-09	0.001

Table 5
Summary of Incremental Risk and Hazard Quotients
Construction Worker – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Inhalation				
Inorganics				
Aluminum	NC	0.0011	NC	0.0010
Antimony	NC	NC	NC	NC
Arsenic	7.69E-11	NC	3.37E-11	NC
Cadmium	7.18E-12	NC	3.15E-12	NC
Cyanide	NC	NC	NC	NC
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	0.0000	NC	0.0000
Thallium	NC	NC	NC	NC
Vanadium	NC	NC	NC	NC
Fluoride	NC	NC	NC	NC
Nitrate	NC	NC	NC	NC
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	1.24E-13	NC	5.42E-14	NC
Benzo(a)pyrene	1.24E-12	NC	5.45E-13	NC
Benzo(b)fluoranthene	1.42E-13	NC	6.23E-14	NC
Dibenzo(a,h)anthracene	4.51E-13	NC	1.98E-13	NC
Indeno(1,2,3-cd)pyrene	1.53E-13	NC	6.69E-14	NC
Pesticides/PCBs				
Dieldrin	1.76E-13	NC	7.71E-14	NC
Heptachlor epoxide	1.30E-14	NC	5.67E-15	NC
Aroclor-1254	4.79E-13	NC	2.10E-13	NC
Aroclor-1260	1.38E-13	NC	6.03E-14	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	4.80E-12	NC	2.10E-12	NC
Total Inhalation	**9.18E-11**	**0.001**	**4.02E-11**	**0.0010**

Table 6 - Summary of Incremental Risk and Hazard Quotients
Construction Worker – Subsurface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Ingestion				
Inorganics				
Aluminum	NC	0.09	NC	0.025
Arsenic	6.02E-07	0.09	7.99E-08	0.025
Lead	NC	NC	NC	NC
Vanadium	NC	0.04	NC	0.011
Fluoride	NC	0.02	NC	0.006
Nitrate	NC	0.000	NC	0.000
Organics				
Benzo(a)pyrene	3.43E-08	NC	4.56E-09	NC
Benzo(a)anthracene	4.38E-09	NC	5.81E-10	NC
Dibenzo(a,h)anthracene	7.74E-08	NC	1.03E-08	NC
Pesticides/PCBs/D&Fs				
Aldrin	1.29E-08	0.002	1.72E-09	0.000
Dieldrin	2.06E-08	0.002	2.73E-09	0.000
Aroclor-1254	4.07E-08	0.07	5.40E-09	0.019
Aroclor-1260	2.05E-08	NC	2.72E-09	NC
TEQ - WHO	7.67E-07	NC	1.02E-07	0.000
Total Ingestion	**1.58E-06**	**0.32**	**2.10E-07**	**0.09**
Dermal				
Inorganics				
Aluminum	NC	0.0004	NC	0.0001
Arsenic	2.48E-09	0.0004	1.82E-10	0.0001
Lead	NC	NC	NC	NC
Vanadium	NC	0.0066	NC	0.0010
Fluoride	NC	0.0001	NC	0.0000
Nitrate	NC	0.0000	NC	0.0000
Organics				
Benzo(a)pyrene	1.42E-10	NC	1.04E-11	NC
Benzo(a)anthracene	1.80E-10	NC	1.32E-11	NC
Dibenzo(a,h)anthracene	3.19E-09	NC	2.34E-10	NC
Pesticides/PCBs/D&Fs				
Aldrin	5.33E-10	0.0001	3.92E-11	0.0000
Dieldrin	8.49E-10	0.0001	6.23E-11	0.0000
Aroclor-1254	1.68E-09	0.0029	1.23E-10	0.0004
Aroclor-1260	8.44E-11	NC	6.20E-12	NC
TEQ-WHO	3.16E-09	NC	2.32E-10	NC
Total Dermal	**1.23E-08**	**0.011**	**9.03E-10**	**0.002**

Table 6
Summary of Incremental Risk and Hazard Quotients
Construction Worker – Subsurface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Inhalation				
Inorganics				
Aluminum	NC	0.001	NC	0.001
Arsenic	1.11E-10	NC	4.84E-11	NC
Lead	NC	NC	NC	NC
Vanadium	NC	NC	NC	NC
Fluoride	NC	NC	NC	NC
Nitrate	NC	NC	NC	NC
Organics				
Benzo(a)pyrene	2.68E-13	NC	1.17E-13	NC
Benzo(a)anthracene	3.39E-14	NC	1.49E-14	NC
Dibenzo(a,h)anthracene	6.00E-13	NC	2.63E-13	NC
Pesticides/PCBs/D&Fs				
Aldrin	2.40E-13	NC	1.05E-13	NC
Dieldrin	3.81E-13	NC	1.67E-13	NC
Aroclor-1254	7.47E-13	NC	3.27E-13	NC
Aroclor-1260	3.76E-13	NC	1.65E-13	NC
TEQ-WHO	1.09E-11	NC	4.77E-12	NC
Total Inhalation	**1.24E-10**	**0.0012**	**5.43E-11**	**0.0010**

Table 7
Summary of Incremental Risk and Hazard Quotients
Construction Worker – Sediment

	RME		CTE	
CONSTITUENT	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Ingestion				
Inorganics				
Arsenic	9.69E-08	0.015	1.29E-08	0.004
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Manganese	NC	0.007	NC	0.002
Vanadium	NC	0.008	NC	0.002
Nitrate	NC	6.1E-06	NC	1.6E-06
Organics				
Acetophenone	NC	1.4E-06	NC	3.7E-07
Benzo(a)pyrene	8.42E-08	NC	1.12E-08	NC
Total Ingestion	**1.81E-07**	**0.03**	**2.40E-08**	**0.008**
Dermal				
Inorganics				
Arsenic	3.99E-10	0.0001	2.93E-11	9.1E-06
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Manganese	NC	0.0007	NC	0.00011
Vanadium	NC	0.0012	NC	0.00018
Nitrate	NC	2.5E-08	NC	3.7E-09
Organics				
Acetophenone	NC	5.7E-09	NC	8.4E-10
Benzo(a)pyrene	3.47E-10	NC	2.55E-11	NC
Total Dermal	**7.46E-10**	**0.002**	**5.48E-11**	**0.0003**

Table 8
Summary of Incremental Risk and Hazard Quotients
Construction Worker – Surface Water

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Ingestion				
Inorganics				
Iron	NC	NC	NC	NC
Manganese	NC	0.00059	NC	0.00051
Organics				
Bis (2 ethylhexyl)phthalate	3.33E-10	0.00008	1.46E-10	0.00007
Total Ingestion	**3.33E-10**	**0.00067**	**1.46E-10**	**0.0006**
Dermal				
Inorganics				
Iron	NC	NC	NC	NC
Manganese	NC	0.016	NC	0.012
Organics				
Bis (2-ethylhexyl)phthalate	1.19E-08	0.0030	4.39E-09	0.0022
Total Dermal	**1.19E-08**	**0.019**	**4.39E-09**	**0.014**

Table 9
Summary of Incremental Risk and Hazard Quotients
Adolescent Trespasser – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
	Ingestion			
Inorganics				
Aluminum	NC	0.0038	NC	0.0019
Antimony	NC	0.0009	NC	0.0005
Arsenic	1.89E-07	0.0029	4.74E-08	0.0015
Cadmium	NC	0.0002	NC	0.0001
Cyanide	NC	0.0000	NC	0.0000
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	NC	NC	NC
Thallium	NC	NC	NC	NC
Vanadium	NC	0.0018	NC	0.0009
Fluoride	NC	0.0002	NC	0.0001
Nitrate	NC	0.0000	NC	0.0000
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	7.22E-09	NC	1.81E-09	NC
Benzo(a)pyrene	7.22E-08	NC	1.81E-08	NC
Benzo(b)fluoranthene	8.30E-09	NC	2.08E-09	NC
Dibenzo(a,h)anthracene	2.64E-08	NC	6.59E-09	NC
Indeno(1,2,3-cd)pyrene	8.91E-09	NC	2.23E-09	NC
Pesticides/PCBs				
Dieldrin	4.31E-09	0.0000	1.08E-09	0.0000
Heptachlor epoxide	3.19E-10	0.0000	7.98E-11	0.0000
Aroclor-1254	1.18E-08	0.0006	2.95E-09	0.0003
Aroclor-1260	3.39E-09	NC	8.49E-10	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	1.53E-07	NC	3.82E-08	NC
Total Ingestion	**4.85E-07**	**0.011**	**1.21E-07**	**0.005**

Table 9
Summary of Incremental Risk and Hazard Quotients
Adolescent Trespasser – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Dermal				
Inorganics				
Aluminum	NC	1.1E-04	NC	8.5E-06
Antimony	NC	1.7E-04	NC	1.4E-05
Arsenic	5.22E-09	8.1E-05	2.11E-10	6.6E-06
Cadmium	NC	2.2E-04	NC	1.8E-05
Cyanide	NC	1.9E-07	NC	1.6E-08
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	NC	NC	NC
Thallium	NC	NC	NC	NC
Vanadium	NC	1.9E-03	NC	1.5E-04
Fluoride	NC	6.9E-06	NC	5.6E-07
Nitrate	NC	8.2E-09	NC	6.7E-10
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	1.99E-09	NC	8.06E-11	NC
Benzo(a)pyrene	1.99E-08	NC	8.06E-10	NC
Benzo(b)fluoranthene	2.29E-09	NC	9.27E-11	NC
Dibenzo(a,h)anthracene	7.26E-09	NC	2.94E-10	NC
Indeno(1,2,3-cd)pyrene	2.45E-09	NC	9.95E-11	NC
Pesticides/PCBs				
Dieldrin	1.19E-09	1.0E-05	4.81E-11	8.4E-07
Heptachlor epoxide	8.79E-11	5.2E-06	3.56E-12	4.2E-07
Aroclor-1254	3.25E-09	5.7E-04	1.32E-10	4.6E-05
Aroclor-1260	9.35E-10	NC	3.79E-11	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	4.21E-08	NC	1.71E-09	NC
Total Dermal	**8.67E-08**	**0.003**	**3.51E-09**	**0.0002**

Table 9
Summary of Incremental Risk and Hazard Quotients
Adolescent Trespasser – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Inhalation				
Inorganics				
Aluminum	NC	1.5E-05	NC	4.9E-06
Antimony	NC	NC	NC	NC
Arsenic	1.03E-11	NC	1.72E-12	NC
Cadmium	9.65E-13	NC	1.61E-13	NC
Cyanide	NC	NC	NC	NC
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	1.6E-09	NC	5.4E-10
Thallium	NC	NC	NC	NC
Vanadium	NC	NC	NC	NC
Fluoride	NC	NC	NC	NC
Nitrate	NC	NC	NC	NC
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	1.66E-14	NC	2.77E-15	NC
Benzo(a)pyrene	1.67E-13	NC	2.79E-14	NC
Benzo(b)fluoranthene	1.91E-14	NC	3.19E-15	NC
Dibenzo(a,h)anthracene	6.07E-14	NC	1.01E-14	NC
Indeno(1,2,3-cd)pyrene	2.05E-14	NC	3.42E-15	NC
Pesticides/PCBs				
Dieldrin	2.36E-14	NC	3.94E-15	NC
Heptachlor epoxide	1.74E-15	NC	2.90E-16	NC
Aroclor-1254	6.44E-14	NC	1.07E-14	NC
Aroclor-1260	1.85E-14	NC	3.09E-15	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	6.45E-13	NC	1.08E-13	NC
Total Inhalation	**1.23E-11**	**0.00001**	**2.06E-12**	**0.000005**

Table 10
Summary of Incremental Risk and Hazard Quotients
Adolescent Trespasser – Sediment

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Ingestion				
Inorganics				
Arsenic	4.38E-08	0.0007	1.10E-08	0.00034
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Manganese	NC	0.00033	NC	0.00016
Vanadium	NC	0.00035	NC	0.00018
Nitrate	NC	2.7E-07	NC	1.4E-07
Organics				
Acetophenone	NC	6.3E-08	NC	3.1E-08
Benzo(a)pyrene	3.81E-08	NC	9.52E-09	NC
Total Ingestion	**8.19E-08**	**0.0014**	**2.05E-08**	**0.0007**
Dermal				
Inorganics				
Arsenic	1.21E-09	0.00002	4.89E-11	0.00000
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Manganese	NC	0.00023	NC	0.00002
Vanadium	NC	0.00038	NC	0.00003
Nitrate	NC	7.5E-09	NC	6.1E-10
Organics				
Acetophenone	NC	1.7E-09	NC	1.4E-10
Benzo(a)pyrene	1.05E-09	NC	4.25E-11	NC
Total Dermal	**2.26E-09**	**0.0006**	**9.14E-11**	**0.0001**

Table 11
Summary of Incremental Risk and Hazard Quotients
Adolescent Trespasser – Surface Water

CONSTITUENT	RME		GTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Ingestion				
Inorganics				
Iron	NC	NC	NC	NC
Manganese	NC	0.00009	NC	0.00004
Organics				
Bis (2-ethylhexyl)phthalate	4.97E-10	0.00001	1.24E-10	6.2E-06
Total Ingestion	**4.97E-10**	**0.0001**	**1.24E-10**	**0.00005**
Dermal				
Inorganics				
Iron	NC	NC	NC	NC
Manganese	NC	0.00091	NC	0.00024
Organics				
Bis (2-ethylhexyl)phthalate	6.77E-09	0.000169	9.15E-10	0.00005
Total Dermal	**6.77E-09**	**0.0011**	**9.15E-10**	**0.00029**

Table 12
Summary of Incremental Risk and Hazard Quotients
Industrial Worker – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Ingestion				
Inorganics				
Aluminum	NC	0.013	NC	0.0022
Antimony	NC	0.003	NC	0.0005
Arsenic	1.59E-06	0.010	1.00E-07	0.0017
Cadmium	NC	0.001	NC	0.0001
Cyanide	NC	0.000	NC	0.0000
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	NC	NC	NC
Thallium	NC	NC	NC	NC
Vanadium	NC	0.006	NC	0.0010
Fluoride	NC	0.001	NC	0.0001
Nitrate	NC	0.000	NC	0.0000
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	6.05E-08	NC	3.81E-09	NC
Benzo(a)pyrene	6.05E-07	NC	3.81E-08	NC
Benzo(b)fluoranthene	6.95E-08	NC	4.38E-09	NC
Dibenzo(a,h)anthracene	2.21E-07	NC	1.39E-08	NC
Indeno(1,2,3-cd)pyrene	7.46E-08	NC	4.71E-09	NC
Pesticides/PCBs				
Dieldrin	3.61E-08	0.000	2.27E-09	0.0000
Heptachlor epoxide	2.67E-09	0.000	1.68E-10	0.0000
Aroclor-1254	9.89E-08	0.007	6.24E-09	0.0012
Aroclor-1260	2.84E-08	NC	1.79E-09	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	1.28E-06	NC	8.08E-08	NC
Total Ingestion	**4.06E-06**	**0.04**	**2.56E-07**	**0.007**

Table 12
Summary of Incremental Risk and Hazard Quotients
Industrial Worker – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Dermal				
Inorganics				
Aluminum	NC	0.00035	NC	0.00005
Antimony	NC	0.00055	NC	0.00008
Arsenic	4.31E-08	0.00027	2.28E-09	0.00004
Cadmium	NC	0.00072	NC	0.00011
Cyanide	NC	0.00000	NC	0.00000
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	NC	NC	NC
Thallium	NC	NC	NC	NC
Vanadium	NC	0.00619	NC	0.00091
Fluoride	NC	0.00002	NC	0.00000
Nitrate	NC	0.00000	NC	0.00000
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	1.64E-08	NC	8.69E-10	NC
Benzo(a)pyrene	1.64E-07	NC	8.69E-09	NC
Benzo(b)fluoranthene	1.89E-08	NC	1.00E-09	NC
Dibenzo(a,h)anthracene	6.00E-08	NC	3.17E-09	NC
Indeno(1,2,3-cd)pyrene	2.03E-08	NC	1.07E-09	NC
Pesticides/PCBs				
Dieldrin	9.81E-09	0.00003	5.19E-10	0.00001
Heptachlor epoxide	7.27E-10	0.00002	3.84E-11	0.00000
Aroclor-1254	2.69E-08	0.00188	1.42E-09	0.00028
Aroclor-1260	7.73E-09	NC	4.09E-10	NC
Dixons/Furans				
Dioxins/Furans(WHO)	3.48E-07	NC	1.84E-08	NC
Total Dermal	**7.17E-07**	**0.010**	**3.79E-08**	**0.001**

Table 12
Summary of Incremental Risk and Hazard Quotients
Industrial Worker – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Inhalation				
Inorganics				
Aluminum	NC	0.0007	NC	0.0006
Antimony	NC	NC	NC	NC
Arsenic	1.15E-09	NC	3.64E-10	NC
Cadmium	1.08E-10	NC	3.40E-11	NC
Cyanide	NC	NC	NC	NC
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	0.0000	NC	0.0000
Thallium	NC	NC	NC	NC
Vanadium	NC	NC	NC	NC
Fluoride	NC	NC	NC	NC
Nitrate	NC	NC	NC	NC
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	1.86E-12	NC	5.85E-13	NC
Benzo(a)pyrene	1.87E-11	NC	5.89E-12	NC
Benzo(b)fluoranthene	2.13E-12	NC	6.73E-13	NC
Dibenzo(a,h)anthracene	6.77E-12	NC	2.14E-12	NC
Indeno(1,2,3-cd)pyrene	2.29E-12	NC	7.22E-13	NC
Pesticides/PCBs				
Dieldrin	2.64E-12	NC	8.32E-13	NC
Heptachlor epoxide	1.94E-13	NC	6.13E-14	NC
Aroclor-1254	7.19E-12	NC	2.27E-12	NC
Aroclor-1260	2.07E-12	NC	6.52E-13	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	7.20E-11	NC	2.27E-11	NC
Total Inhalation	**1.38E-09**	**0.0007**	**4.34E-10**	**0.0006**

Table 13 - Summary of Incremental Risk and Hazard Quotients
Industrial Worker – Subsurface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Ingestion				
Inorganics				
Aluminum	NC	0.014	NC	0.002
Arsenic	2.28E-06	0.014	1.44E-07	0.002
Lead	NC	NC	NC	NC
Vanadium	NC	0.006	NC	0.001
Fluoride	NC	0.003	NC	0.001
Nitrate	NC	0.0000	NC	0.000
Organics				
Benzo(a)pyrene	1.30E-07	NC	8.21E-09	NC
Benzo(a)anthracene	1.66E-08	NC	1.05E-09	NC
Dibenzo(a,h)anthracene	2.93E-07	NC	1.85E-08	NC
Pesticides/PCBs/D&Fs				
Aldrin	4.90E-08	0.0003	3.09E-09	0.0000
Dieldrin	7.80E-08	0.0003	4.92E-09	0.0000
Aroclor-1254	1.54E-07	0.011	9.72E-09	0.002
Aroclor-1260	7.76E-08	NC	4.89E-09	NC
TEQ - WHO	2.90E-06	NC	1.83E-07	NC
Total Ingestion	**5.98E-06**	**0.05**	**3.77E-07**	**0.009**
Dermal				
Inorganics				
Aluminum	NC	0.0004	NC	0.0001
Arsenic	6.2E-08	0.0004	3.3E-09	0.0001
Lead	NC	NC	NC	NC
Vanadium	NC	0.0066	NC	0.0010
Fluoride	NC	0.0001	NC	0.0000
Nitrate	NC	0.0000	NC	0.0000
Organics				
Benzo(a)pyrene	3.5E-09	NC	1.9E-10	NC
Benzo(a)anthracene	4.5E-09	NC	2.4E-10	NC
Dibenzo(a,h)anthracene	8.0E-08	NC	4.2E-09	NC
Pesticides/PCBs/D&Fs				
Aldrin	1.3E-08	0.0001	7.0E-10	0.0000
Dieldrin	2.1E-08	0.0001	1.1E-09	0.0000
Aroclor-1254	4.2E-08	0.0029	2.2E-09	0.0004
Aroclor-1260	2.1E-08	NC	1.1E-09	NC
TEQ - WHO	7.9E-07	NC	4.2E-08	NC
Total Dermal	**1.04E-06**	**0.011**	**5.48E-08**	**0.002**

Table 13
Summary of Incremental Risk and Hazard Quotients
Industrial Worker – Subsurface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Inhalation				
Inorganics				
Aluminum	NC	7.18E-04	NC	6.29E-04
Arsenic	1.66E-09	NC	5.23E-10	NC
Lead	NC	NC	NC	NC
Vanadium	NC	NC	NC	NC
Fluoride	NC	NC	NC	NC
Nitrate	NC	NC	NC	NC
Organics				
Benzo(a)pyrene	4.02E-12	NC	1.27E-12	NC
Benzo(a)anthracene	5.09E-13	NC	1.60E-13	NC
Dibenzo(a,h)anthracene	9.00E-12	NC	2.84E-12	NC
Pesticides/PCBs/D&Fs				
Aldrin	3.61E-12	NC	1.14E-12	NC
Dieldrin	5.71E-12	NC	1.80E-12	NC
Aroclor-1254	1.12E-11	NC	3.53E-12	NC
Aroclor-1260	5.64E-12	NC	1.78E-12	NC
TEQ - WHO	1.63E-10	NC	5.15E-11	NC
Total Inhalation	**1.86E-09**	**0.0007**	**5.87E-10**	**0.0006**

Table 14
Summary of Incremental Risk and Hazard Quotients
Commercial Worker – Surface Soil

CONSTITUENT	RME CARCINOGENIC RISK	RME HAZARD QUOTIENT	CTE CARCINOGENIC RISK	CTE HAZARD QUOTIENT
Ingestion				
Inorganics				
Aluminum	NC	0.013	NC	0.0022
Antimony	NC	0.003	NC	0.0005
Arsenic	1.59E-06	0.010	1.00E-07	0.0017
Cadmium	NC	0.001	NC	0.0001
Cyanide	NC	0.000	NC	0.0000
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	NC	NC	NC
Thallium	NC	NC	NC	NC
Vanadium	NC	0.006	NC	0.0010
Fluoride	NC	0.001	NC	0.0001
Nitrate	NC	0.000	NC	0.0000
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	6.05E-08	NC	3.81E-09	NC
Benzo(a)pyrene	6.05E-07	NC	3.81E-08	NC
Benzo(b)fluoranthene	6.95E-08	NC	4.38E-09	NC
Dibenzo(a,h)anthracene	2.21E-07	NC	1.39E-08	NC
Indeno(1,2,3-cd)pyrene	7.46E-08	NC	4.71E-09	NC
Pesticides/PCBs				
Dieldrin	3.61E-08	0.000	2.27E-09	0.0000
Heptachlor epoxide	2.67E-09	0.000	1.68E-10	0.0000
Aroclor-1254	9.89E-08	0.007	6.24E-09	0.0012
Aroclor-1260	2.84E-08	NC	1.79E-09	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	1.28E-06	NC	8.08E-08	NC
Total Ingestion	**4.06E-06**	**0.04**	**2.56E-07**	**0.007**

Table 14
Summary of Incremental Risk and Hazard Quotients
Commercial Worker – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Dermal				
Inorganics				
Aluminum	NC	0.0003	NC	5.1E-05
Antimony	NC	0.0006	NC	8.1E-05
Arsenic	4.31E-08	0.0003	2.28E-09	3.9E-05
Cadmium	NC	0.0007	NC	1.1E-04
Cyanide	NC	0.0000	NC	9.4E-08
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	NC	NC	NC
Thallium	NC	NC	NC	NC
Vanadium	NC	0.0062	NC	9.1E-04
Fluoride	NC	0.0000	NC	3.3E-06
Nitrate	NC	0.0000	NC	4.0E-09
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	1.64E-08	NC	8.69E-10	NC
Benzo(a)pyrene	1.64E-07	NC	8.69E-09	NC
Benzo(b)fluoranthene	1.89E-08	NC	1.00E-09	NC
Dibenzo(a,h)anthracene	6.00E-08	NC	3.17E-09	NC
Indeno(1,2,3-cd)pyrene	2.03E-08	NC	1.07E-09	NC
Pesticides/PCBs				
Dieldrin	9.81E-09	0.0000	5.19E-10	5.0E-06
Heptachlor epoxide	7.27E-10	0.0000	3.84E-11	2.5E-06
Aroclor-1254	2.69E-08	0.0019	1.42E-09	2.8E-04
Aroclor-1260	7.73E-09	NC	4.09E-10	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	3.48E-07	NC	1.84E-08	NC
Total Dermal	**7.17E-07**	**0.010**	**3.79E-08**	**0.001**

Table 14
Summary of Incremental Risk and Hazard Quotients
Commercial Worker – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Inhalation				
Inorganics				
Aluminum	NC	6.52E-04	NC	0.0006
Antimony	NC	NC	NC	NC
Arsenic	1.15E-09	NC	3.64E-10	NC
Cadmium	1.08E-10	NC	3.40E-11	NC
Cyanide	NC	NC	NC	NC
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	7.24E-08	NC	6.34E-08
Thallium	NC	NC	NC	NC
Vanadium	NC	NC	NC	NC
Fluoride	NC	NC	NC	NC
Nitrate	NC	NC	NC	NC
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	1.86E-12	NC	5.85E-13	NC
Benzo(a)pyrene	1.87E-11	NC	5.89E-12	NC
Benzo(b)fluoranthene	2.13E-12	NC	6.73E-13	NC
Dibenzo(a,h)anthracene	6.77E-12	NC	2.14E-12	NC
Indeno(1,2,3-cd)pyrene	2.29E-12	NC	7.22E-13	NC
Pesticides/PCBs				
Dieldrin	2.64E-12	NC	8.32E-13	NC
Heptachlor epoxide	1.94E-13	NC	6.13E-14	NC
Aroclor-1254	7.19E-12	NC	2.27E-12	NC
Aroclor-1260	2.07E-12	NC	6.52E-13	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	7.20E-11	NC	2.27E-11	NC
Total Inhalation	**1.38E-09**	**0.0007**	**4.34E-10**	**0.0006**

Table 15
Summary of Incremental Risk and Hazard Quotients
Commercial Worker – Surface Water

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Ingestion				
Inorganics				
Iron	NC	NC	NC	NC
Manganese	NC	0.0006	NC	0.0005
Organics				
Bis (2-ethylhexyl)phthalate	8.32E-09	0.00008	2 62E-09	0.00007
Total Ingestion	**8.32E-09**	**0.0007**	**2.62E-09**	**0.0006**
Dermal				
Inorganics				
Iron	NC	NC	NC	NC
Manganese	NC	0.016	NC	0.012
Organics				
Bis (2-ethylhexyl)phthalate	2.99E-07	0.0030	7.89E-08	0.0022
Total Dermal	**2.99E-07**	**0.019**	**7.89E-08**	**0.014**

Table 16
Summary of Incremental Risk and Hazard Quotients
Resident – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Ingestion				
Inorganics				
Aluminum	NC	0.036	NC	0.0024
Antimony	NC	0.009	NC	0.0006
Arsenic	5.33E-06	0.028	1.07E-07	0.0018
Cadmium	NC	0.002	NC	0.0001
Cyanide	NC	0.000	NC	0.0000
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	NC	NC	NC
Thallium	NC	NC	NC	NC
Vanadium	NC	0.017	NC	0.0011
Fluoride	NC	0.002	NC	0.0002
Nitrate	NC	0.000	NC	0.0000
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	2.03E-07	NC	4.07E-09	NC
Benzo(a)pyrene	2.03E-06	NC	4.07E-08	NC
Benzo(b)fluoranthene	2.34E-07	NC	4.68E-09	NC
Dibenzo(a,h)anthracene	7.41E-07	NC	1.49E-08	NC
Indeno(1,2,3-cd)pyrene	2.51E-07	NC	5.03E-09	NC
Pesticides/PCBs				
Dieldrin	1.21E-07	0.000	2.43E-09	0.0000
Heptachlor epoxide	8.98E-09	0.000	1.80E-10	0.0000
Aroclor-1254	3.32E-07	0.006	6.66E-09	0.0004
Aroclor-1260	9.55E-08	NC	1.91E-09	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	4.30E-06	NC	8.63E-08	NC
Total Ingestion	**1.36E-05**	**0.10**	**2.74E-07**	**0.007**

Table 16
Summary of Incremental Risk and Hazard Quotients
Resident – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Dermal				
Inorganics				
Aluminum	NC	0.002	NC	0.0003
Antimony	NC	0.003	NC	0.0004
Arsenic	3.04E-07	0.002	1.22E-08	0.0002
Cadmium	NC	0.004	NC	0.0006
Cyanide	NC	0.000	NC	0.0000
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	NC	NC	NC
Thallium	NC	NC	NC	NC
Vanadium	NC	0.036	NC	0.0049
Fluoride	NC	0.000	NC	0.0000
Nitrate	NC	0.000	NC	0.0000
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	1.16E-07	NC	4.64E-09	NC
Benzo(a)pyrene	1.16E-06	NC	4.64E-08	NC
Benzo(b)fluoranthene	1.33E-07	NC	5.34E-09	NC
Dibenzo(a,h)anthracene	4.23E-07	NC	1.70E-08	NC
Indeno(1,2,3-cd)pyrene	1.43E-07	NC	5.73E-09	NC
Pesticides/PCBs				
Dieldrin	6.91E-08	0.000	2.77E-09	0.0000
Heptachlor epoxide	5.12E-09	0.000	2.05E-10	0.0000
Aroclor-1254	1.89E-07	0.011	7.60E-09	0.0015
Aroclor-1260	5.44E-08	NC	2.18E-09	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	2.45E-06	NC	9.84E-08	NC
Total Dermal	**5.05E-06**	**0.06**	**2.02E-07**	**0.008**

Table 16
Summary of Incremental Risk and Hazard Quotients
Resident – Surface Soil

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Inhalation				
Inorganics				
Aluminum	NC	0.0012	NC	0.00077
Antimony	NC	NC	NC	NC
Arsenic	2.45E-09	NC	4.92E-10	NC
Cadmium	2.29E-10	NC	4.60E-11	NC
Cyanide	NC	NC	NC	NC
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Mercury	NC	0.0000	NC	0.00000
Thallium	NC	NC	NC	NC
Vanadium	NC	NC	NC	NC
Fluoride	NC	NC	NC	NC
Nitrate	NC	NC	NC	NC
Organics				
2,4-Dinitrotoluene	NC	NC	NC	NC
Acetophenone	NC	NC	NC	NC
Benzo(a)anthracene	3.95E-12	NC	7.92E-13	NC
Benzo(a)pyrene	3.97E-11	NC	7.97E-12	NC
Benzo(b)fluoranthene	4.54E-12	NC	9.10E-13	NC
Dibenzo(a,h)anthracene	1.44E-11	NC	2.89E-12	NC
Indeno(1,2,3-cd)pyrene	4.87E-12	NC	9.77E-13	NC
Pesticides/PCBs				
Dieldrin	5.62E-12	NC	1.13E-12	NC
Heptachlor epoxide	4.13E-13	NC	8.29E-14	NC
Aroclor-1254	1.53E-11	NC	3.07E-12	NC
Aroclor-1260	4.40E-12	NC	8.82E-13	NC
Dioxins/Furans				
Dioxins/Furans(WHO)	1.53E-10	NC	3.07E-11	NC
Total Inhalation	**2.93E-09**	**0.001**	**5.88E-10**	**0.0008**

Table 17
Summary of Incremental Risk and Hazard Quotients
Resident – Surface Water

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Ingestion				
Inorganics				
Iron	NC	NC	NC	NC
Manganese	NC	0.00082	NC	0.0005
Organics				
Bis (2-ethylhexyl)phthalate	1.40E-08	0.00012	2.80E-09	0.000078
Total Ingestion	**1.40E-08**	**0.001**	**2.80E-09**	**0.0006**
Dermal				
Inorganics				
Iron	NC	NC	NC	NC
Manganese	NC	0.28	NC	0.13
Organics				
Bis (2-ethylhexyl)phthalate	6.31E-06	0.053	8.43E-07	0.023
Total Dermal	**6.31E-06**	**0.33**	**8.43E-07**	**0.15**

Table 18
Summary of Incremental Risk and Hazard Quotients
Resident – Groundwater

CONSTITUENT	RME		CTE	
	CARCINOGENIC RISK	HAZARD QUOTIENT	CARCINOGENIC RISK	HAZARD QUOTIENT
Ingestion				
Inorganics				
Aluminum	NC	2.7	NC	1.3
Arsenic	8.10E-05	0.4	1.14E-05	0.2
Beryllium	1.33E-03	0.4	1.86E-04	0.2
Cadmium	NC	0.5	NC	0.3
Chromium	NC	0.0	NC	0.0
Cobalt	NC	0.5	NC	0.2
Copper	NC	0.1	NC	0.1
Cyanide	NC	0.0	NC	0.0
Fluoride	NC	42.6	NC	19.9
Iron	NC	NC	NC	NC
Lead	NC	NC	NC	NC
Manganese	NC	12.3	NC	5.7
Nickel	NC	0.5	NC	0.3
Nitrate-N	NC	1.1	NC	0.5
Selenium	NC	NC	NC	NC
Thallium	NC	NC	NC	NC
Vanadium	NC	0.1	NC	0.1
Zinc	NC	0.1	NC	0.0
Organics				
Alpha-BHC	4.14E-06	NC	5.82E-07	NC
Beta-BHC	8.03E-07	NC	1.13E-07	NC
Benzene	1.87E-05	0.20	2.63E-06	0.09
Chloroform	4.15E-08	0.00	5.83E-09	0.00
2-Nitrotoluene	NC	0.00	NC	0.00
4-Nitrotoluene	NC	0.00	NC	0.00
2,4-Dinitrotoluene	3.22E-03	5.52	4.52E-04	2.58
2,6-Dinitrotoluene	5.64E-05	0.10	7.93E-06	0.05
1,3-Dintrobenzene	NC	0.47	NC	0.29
2,4,6-Trinitrotoluene	8.10E-07	0.13	5.93E-08	0.03
Naphthalene	5.82E-07	0.00	8.18E-08	0.00
2-Methylnaphthalene	NC	NC	NC	NC
Tetrachloroethene	1.71E-06	0.01	2.40E-07	0.00
Vinyl Chloride	1.27E-05	0.01	1.78E-06	0.00
Xylenes	NC	0.00	NC	0.00
Total Ingestion	**4.72E-03**	**67.8**	**6.63E-04**	**31.8**

Table 19 presents a summary of estimated noncarcinogenic hazards and incremental carcinogenic risks for the potentially exposed populations at the Site based on RME assumptions. A HI below 1.0 indicates that adverse noncarcinogenic health effects for these receptors are not expected to occur under the exposures evaluated.

EPA has established a range of 1×10^{-4} to 1×10^{-6} for excess lifetime carcinogenic risks. Future land use scenarios and RME assumptions for the hypothetical resident was estimated to be greater than the upper end of the EPA target risk range. This estimated incremental potential RME risk for hypothetical future residential use of groundwater was responsible for estimated risks above EPA's risk range.

7.1.5 Constituent of Concern (COC) Determination

COCs are defined as those COPCs that significantly contribute to an exposure pathway that either exceeds a 1×10^{-4} cumulative incremental cancer risk; or exceeds a non-carcinogenic HI of 1. Generally, exceeding a 1×10^{-4} cumulative site risk level and a HI of 1 warrants action under CERCLA. Constituents are considered as significant contributors to the pathway risk, and therefore included as COCs, if their individual carcinogenic risk contribution is greater than 1×10^{-6} and their noncarcinogenic HQ is greater than 0.1.

Groundwater COCs are also identified by comparison to appropriate ARARs. In this case, the exposure point concentrations of groundwater COPCs were compared to federal and state primary MCLs. On this basis, beryllium, cadmium, lead, benzene, fluoride, thallium and nitrate are designated as groundwater COCs.

7.1.6 Uncertainty Analysis

The primary goal of the uncertainty analysis is to provide a discussion of the key assumptions made in the risk assessment that may significantly influence the estimate of potential risk. Uncertainty is inherent in all of the principle components of the risk assessment. A discussion of the sources of uncertainty contributing to the potential risk and the associated effects (overestimation or underestimation of risk) of these factors is presented herein. In the absence of empirical- or site-specific data, assumptions are developed based on best estimates of exposure or dose-response relationships. To assist in the development of these estimates, EPA (1989, 1991) recommends the use of guidelines and standard factors in risk assessments conducted under CERCLA. The use of these standard factors is intended to promote consistency among risk assessments where assumptions must be made. Although the use of standard factors undoubtedly promotes comparability, their usefulness in accurately predicting potential risk is directly related to their applicability to the actual site-specific conditions.

Table 19
Hazard and Incremental Risk Summary by Media

Receptor/Media of Concern	RME		CTE	
	Risk	Hazard	Risk	Hazard
Current Land Use				
Construction Worker				
Surface Soil	1.10E-06	0.28	1.44E-07	0.073
Subsurface Soil	1.59E-06	0.34	2.11E-07	0.089
Sediment	1.82E-07	0.032	2.41E-08	0.008
Surface Water	3.95E-09	0.018	1.47E-09	0.013
Total for Receptor	**2.88E-06**	**0.67**	**3.81E-07**	**0.18**
Adolescent Trespasser				
Surface Soil	5.72E-07	0.014	1.25E-07	0.006
Sediment	8.42E-08	0.002	2.06E-08	0.001
Surface Water	2.55E-09	0.001	4.01E-10	0.0003
Total for Receptor	**6.59E-07**	**0.017**	**1.46E-07**	**0.007**
Future Land Use				
Industrial Worker				
Surface Soil	4.78E-06	0.051	2.95E-07	0.009
Subsurface Soil	7.02E-06	0.060	4.33E-07	0.011
Total for Receptor	**1.18E-05**	**0.11**	**7.28E-07**	**0.020**
Commercial Worker				
Surface Soil	4.78E-06	0.051	2.95E-07	0.009
Surface Water	9.88E-08	0.018	2.65E-08	0.013
Total for Receptor	**4.88E-06**	**0.069**	**3.22E-07**	**0.022**
Resident				
Surface Soil	1.87E-05	0.16	4.77E-07	0.015
Surface Water	1.93E-06	0.30	2.58E-07	0.13
Groundwater	4.72E-03	67.8	6.63E-04	31.8
Total for Receptor	**4.76E-03**	**68**	**6.64E-04**	**32**

The potential noncarcinogenic hazard and carcinogenic risk estimates for the Site are based on a number of assumptions that incorporate varying degrees of uncertainty resulting from many sources, including the following:

- Environmental monitoring and data evaluation
- Assumptions in the selection of exposure pathways and scenarios
- Estimation of the magnitude of exposure under selected exposure scenarios
- Assumptions in the expression of potential noncarcinogenic hazard and carcinogenic risk

Several factors introduced in the risk assessment may contribute to the uncertainty of the potential risk estimates, including the following:

- Sampling concentrated in areas at the site believed to be affected by constituents (biased sampling) is likely to overestimate exposure.
- Use of environmental data qualified as estimated potentially biases the actual value low or high.
- Using EPA-approved toxicity values with low confidence ratings and high uncertainty factors could potentially overestimate or underestimate the risk calculated in the RI.
- Using toxicity values that are largely based on animal studies and extrapolated to humans could potentially overestimate or underestimate the risk calculated in this RI.
- Not quantitatively evaluating constituents that do not have toxicity data may underestimate actual risk.
- Not quantitatively evaluating synergistic or cumulative toxicity effects associated with the co-occurrence of COPCs in environmental media may underestimate actual risk.
- Compounding conservative assumptions in the risk assessment yield extremely conservative (overestimated) potential risk estimates.
- Assuming constituents present in soils and sediment have a significant tendency to desorb from the soil and pass through the skin is likely to overestimate exposure.
- Using 95% UCL and maximum concentrations is likely to overestimate intakes since actual exposure is probably at lower concentrations.
- The assumption that ingestion exposures correspond to populations spending their entire workdays within the localized affected areas of the site overestimates exposure.

The following discussions detail the key assumptions and uncertainties in each phase of the risk assessment that resulted in a significant contribution to total potential risk.

Characterization of Affected Media

The intent of the RI conducted for the site was to characterize the nature and extent of contamination in various media and potential risk(s) to human health and the environment. To achieve this goal in a timely, cost-effective manner, the investigation focused on those areas of the Site that were known or suspected to be affected by chemical releases. In the absence of a representative sample population *(i.e.,* an equally distributed number of data points from all portions of the Site), the available data used in the baseline risk assessment were assumed to be representative of the entire Site. For the industrial worker and construction worker, this assumption is more likely to overestimate risk than to underestimate it, since potential receptors may spend less time in the sampled areas than the site as a whole.

Exposure Assessment

There are numerous assumptions made in the exposure assessment, including the selection of exposure routes, scenarios, and factors *(e.g.,* contact rates, exposure frequency, body weight) used to estimate exposure doses. The RME was used to develop exposure doses and is defined as the "maximum exposure that is reasonably expected to occur at the site (EPA, 1989)." Several variables that determine the exposure dose for the RME are based on high-end (typically 90th percentile or greater) estimates. These variables are as follows:

- Exposure concentration is the 95% UCL or the maximum concentration observed.
- Intake rate is an upper bound or maximum value.
- Exposure frequency is an average or upper-bound value.
- Exposure duration is an upper-bound value.
- Fraction ingested is an upper-bound (conservative) value.

Therefore, the calculated RME dose for any given constituent, which results from a multiplication of these selected variables, represents a high-end value and a conservative estimate of the actual exposure dose. The use of this exposure dose, coupled with conservative estimates of toxicity, will yield a potential risk result that represents a high-end estimate of the likelihood of noncarcinogenic effects.

Toxicity Assessment

In order for a potential risk to be present, both exposure to the COC and toxicity at the predicted exposure levels must exist. The toxicological uncertainties primarily relate to the methodology by which carcinogenic and noncarcinogenic criteria (i.e., CSFs and Rfds) are developed. The toxicity values developed by EPA are designed to represent a conservative position, may not reflect the current scientific consensus, and in most instances, will result in an overestimation of potential hazards.

There is considerable scientific debate regarding the nature of dioxin toxicity. The EPA-mandated cancer slope factor of 150,000 $(mg/kg\text{-}day)^{-1}$ is relied upon in incremental risk estimates for this baseline risk assessment. This CSF, published in HEAST, does not represent agency-wide consensus and is footnoted in the HEAST citation as under review and subject to change. However, this value is relied upon for risk assessments under the CERCLA framework. This value may be changed (higher or lower) based on the EPA dioxin reassessment scheduled to be finalized soon. For dermal contact exposures in this baseline risk assessment, oral slope factors and reference doses adjusted for dermal exposure are used. The adjustments are based on studies on each individual parameter when available. However, the uncertainty involved in this adjustment method is high. For inhalation exposures in this baseline risk assessment, EPA has requested that a provisional inhalation SF be used for benzo(a)pyrene. This value has been developed by the National Center for Environmental Assessment (NCEA) and is based on a hamster evaluation using benzo(a)pyrene (USEPA, 2000b). The uncertainty involved in using a provisional inhalation slope factor could underestimate or overestimate risk for this constituent.

7.2 Summary of the Ecological Risk Assessment

This section documents the ecological risk evaluations conducted for the Site. The role of the ecological risk assessment is to 1) determine whether unacceptable risks might be posed to ecological receptors from chemical stressors, 2) derive constituent concentrations which would ensure that unacceptable risks are not posed to ecological receptors, and 3) provide the information necessary to make a risk management decision concerning the practical need and extent of remedial action.

The ecological risk assessment process as defined by guidance can consist of eight steps and five scientific management decision points (SMDPs). The ecological risk assessment process includes the following steps:

- Preliminary Problem Formulation and Ecological Effects Evaluation
- Preliminary Exposure Estimate and Risk Calculation
- Problem Formulation: Assessment Endpoint Selection and Formulation of Testable Hypothesis
- Conceptual Model Development: Conceptual Model Measurement Endpoint Selection and Study Design
- Site Assessment to Confirm Ecological Sampling and Analysis Plan
- Site Field Investigation
- Risk Characterization
- Risk Management

Consistent with EPA guidance, the SMDP follow Steps 2 through 5 and Step 8. At the conclusion of the screening level ecological risk assessment (Step 1 and 2) for the Site, the initial SMDP of the ecological risk assessment process was reached. The Screening Level Ecological Risk Assessment (SLERA; RMT, 2002) indicated that potential conditions exist which result in or may result in a HQ greater than 1.0 for constituents observed at the Site; therefore, a refinement of COPC and problem formulation (Step 3) was prepared. Ecological COPCs for surface water and sediment were not identified. The industrial nature of the site lacks quality ecological habitat areas capable of supporting ecological populations. Upon reaching the SMDP at the conclusion of the ecological COPC refinement process, additional ecological evaluations of the Site were not warranted. This information supports that an expanded problem formulation does not need to be prepared and further ecological risk evaluations are not deemed necessary for the Site.

7.3 Basis for Remedial Action

The response action selected in this ROD is necessary to protect public health or welfare or the environment from actual releases of hazardous substances into the environment. A response action is generally warranted if one or more of the following conditions is met: 1) the cumulative excess carcinogenic risk to an individual exceeds 1E-4 (using RME assumptions for either the current or reasonably anticipated future land use or current or potential beneficial use of ground/surface water; 2) the non-carcinogenic hazard index is greater than one (using RME assumptions for either the current or reasonably anticipated future land use or current or potential use of ground/surface water). The response action is warranted because:

- Groundwater contains contaminants above the MCLs that contribute to an unacceptable risk. The groundwater exposures had the highest excess cancer risks and non-carcinogenic risks of the exposure scenarios evaluated. However, for both current and future populations to be exposed to contaminants would require that untreated potable supply wells be used in the contaminated plumes. Currently, all residences and businesses have access to City water.

8.0 REMEDIAL ACTION OBJECTIVES (RAOs)

RAOs are Site-specific clean-up objectives established for protecting human health and the environment. RAOs specify contaminants and media of concern, and potential exposure pathways and receptors [40 C.F.R. § 300.430 (e)(2)(i)]. RAOs indicate a contaminant level and an exposure route, rather than a contaminant level alone, because protection of human and ecological receptors may be achieved by reducing or eliminating exposure pathways as well as by reducing contaminant concentrations.

The RAOs were developed based on the results of the Human Health and Ecological Risk Assessment and based on ARARs. RAOs were not developed for soils, sediments, or surface water, as these three media do not pose elevated risk to human health or the environment based on the results of the Risk Assessment. RAOs were developed for groundwater, which poses elevated risk through hypothetical future ingestion by residents residing on the IMC Property. RAOs may be qualitative (e.g., to prevent exposure to contaminated groundwater) or quantitative (e.g., to specify the maximum contaminant concentration in groundwater).

The IMC groundwater plume is defined as COC impacted groundwater in the underlying aquifer of the IMC Property. Groundwater RAOs are presented in **Table 20.**

Environmental Media	Table 20 Remedial Action Objectives
Groundwater	For Human Health • Prevent future human exposure (dermal contact, ingestion, and inhalation) to groundwater with contaminants above levels that are protective of beneficial groundwater use. • To restore groundwater to beneficial use in a reasonable time frame For Environmental Protection • To minimize migration of COCs from site groundwater to surface water.

8.1 Cleanup Levels

Cleanup levels are a subset of the RAOs, and they provide the measurable levels for the remedial actions for each medium. In the preamble to the final NCP, EPA explained that cleanup levels are based on applicable or relevant and appropriate requirements (ARARs) where they exist. In the cases where cleanup levels are not based on ARARs, numerical cleanup levels were developed following the EPA guidance document entitled *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual (Part B, Development of Risk Based Preliminary Remediation Goals)*, Interim, December 1991 (EPA, 1991a) and USEPA's Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-30, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (EPA, 1991b).

To meet the RAOs of reducing potential risk and migration at the Site, cleanup levels are established for use in reviewing the RA alternatives. Cleanup levels may be based on human health risk assessment, ecological risk assessment, potential migration to groundwater, and/or groundwater and surface water ARARs.

Chemical-specific ARARs are available for groundwater in the form of Federal/State-specific groundwater standards. Site groundwater concentrations greater than Federal/State-specific groundwater standards are the following constituents: Beryllium, Fluoride, Cadmium, Nitrate, Lead, Benzene, and Thallium. Clean-up levels for groundwater are listed in **Table 21.**

Table 21
Groundwater Cleanup Levels

Contaminant	MCL (ug/l)	Max Found (ug/l)
Beryllium	4	93
Cadmium	5	18
Thallium	2	5.5
Lead	15	47
Fluoride	4,000	211,000
Nitrate	10,000	142,000
Benzene	5	59
2,4-DNT	10 (PQL)	1,310

PQL – practical quantitation limit

Potential migration from soil to groundwater was discussed previously. The RI concluded that process residuals were a likely source of low pH, metals, fertilizer constituents, and DNTs to groundwater. Process residuals were removed during the NTCRA. The Former Sulfuric Acid Plant area was also identified as a source area of low pH to groundwater. Although control of future migration has been identified as a remedial objective, specific soil cleanup levels for migration control are not proposed. Rather the distinct low pH source area is addressed in the remedial alternatives. The low pH source area is characterized as subsurface soil with a soil pH value less than 3.5 s.u. The low pH source area in the Former Sulfuric Acid Plant area is estimated to be 31,700 cubic yards. This volume is based on information obtained during the October 2013 low pH soil evaluation.

Assuming a saturated thickness ranging from 10 to 25 feet and a porosity of 0.3, the volume of potentially affected groundwater is estimated to range from 17 to 44 million gallons.

9.0 DESCRIPTION OF REMEDIAL ALTERNATIVES

Several potentially applicable remedial alternatives were assembled and screened to identify those that warrant a more detailed analysis. The alternatives were screened based on the anticipated effectiveness, implementability, and relative cost with respect to IMC Site conditions. Based on the results of the preliminary screening process, the remedial alternatives listed below have been retained for detailed analysis.

Remedial Alternatives

1: No Action.
2: Infiltration Galleries and ICs.
3: Phytoremediation and ICs.
4: Ex Situ Soil Treatment and Replacement

The following table lists the capital costs, O&M costs, and total present worth costs of each of the retained Remedial Alternatives:

Alternative	Capital Cost	Annual O&M Costs	Present Value (3% rate of return)
1 - No Action	$0	$0	$0
2 – Infiltration Galleries	$1,150,000	$100,400	$2,190,000
3 - Phytoremediation	$492,000	$117,600	$2,300,000
4 – Ex Situ Soil Treatment and Replacement	$4,119,000	$100,400	$5,160,000

9.1 Common Elements of Each Remedial Alternative

With the exception of Alternative 1, all the remedial action alternatives include:

- ICs are non-engineered instruments, such as administrative and/or legal controls, that help to minimize the potential for human exposure to contamination and/or protect the integrity of a remedy. Institutional controls for site-wide groundwater use restrictions would be kept in place until cleanup levels in groundwater are met. In addition to the institutional controls, engineered controls such as the existing security fencing would be maintained to limit access to the Site.

- Performance monitoring would include a baseline sampling event just prior to implementing the remedy and semiannual groundwater monitoring following implementation. If monitoring data suggest, after a reasonable record has been established that less frequent monitoring is appropriate, then the monitoring frequency will be reduced. Two to four additional groundwater monitoring wells are proposed to monitor the performance of this alternative. On an annual basis, an upstream and downstream surface water sample will be collected from Fairforest Creek to confirm that water quality is maintained. Surface water samples will be collected for the same analytical parameters as groundwater. If the groundwater monitoring frequency is adjusted, surface water sampling will be conducted at the same frequency as groundwater sampling.

9.2 Description of Alternatives/Remedy Components

9.2.1 Alternative 1 – No Action

Estimated Capital Costs:	$0
Annual O&M Costs:	$0
Total Present Worth Costs:	$0
Estimated time to construct:	None
Estimated time to achieve RAOs:	None

As required by the NCP, the No Action alternative, reflecting no further action for groundwater or the source of low pH to groundwater, is evaluated as a baseline for comparison to other alternatives. Under this alternative, reduction in COC concentrations will rely on natural physical and chemical processes. Neither groundwater use restriction nor a groundwater monitoring program will be implemented under this alternative.

9.2.2 Alternative 2: Infiltration Galleries

Estimated Capital Costs:	$1,150,000
Annual O&M Costs:	$100,400
Total Present Worth Costs:	$2,190,000
Estimated time to construct:	3 months
Estimated time to achieve RAOs:	15 years

Alternative 2 consists of source remediation for the Northeast groundwater area by applying neutralization chemicals to subsurface soil in the source area. **Figure 31** depicts a hypothetical layout of infiltration galleries. Each gallery would be constructed of perforated 2-foot diameter pipe laid horizontally at a depth of 8 to 10 feet bls. The infiltration galleries are proposed to be arrayed in three rows. The first row is located within the affected soil area. The second row is located about one-third the distance from the affected soil area to Fairforest Creek. The third row is located about half the distance from the second row to Fairforest Creek. Each pipe would be filled with a neutralizing chemical solution such as sodium carbonate. The chemical would drain by gravity from the pipe, neutralizing underlying soil. Eventually, the infiltrated

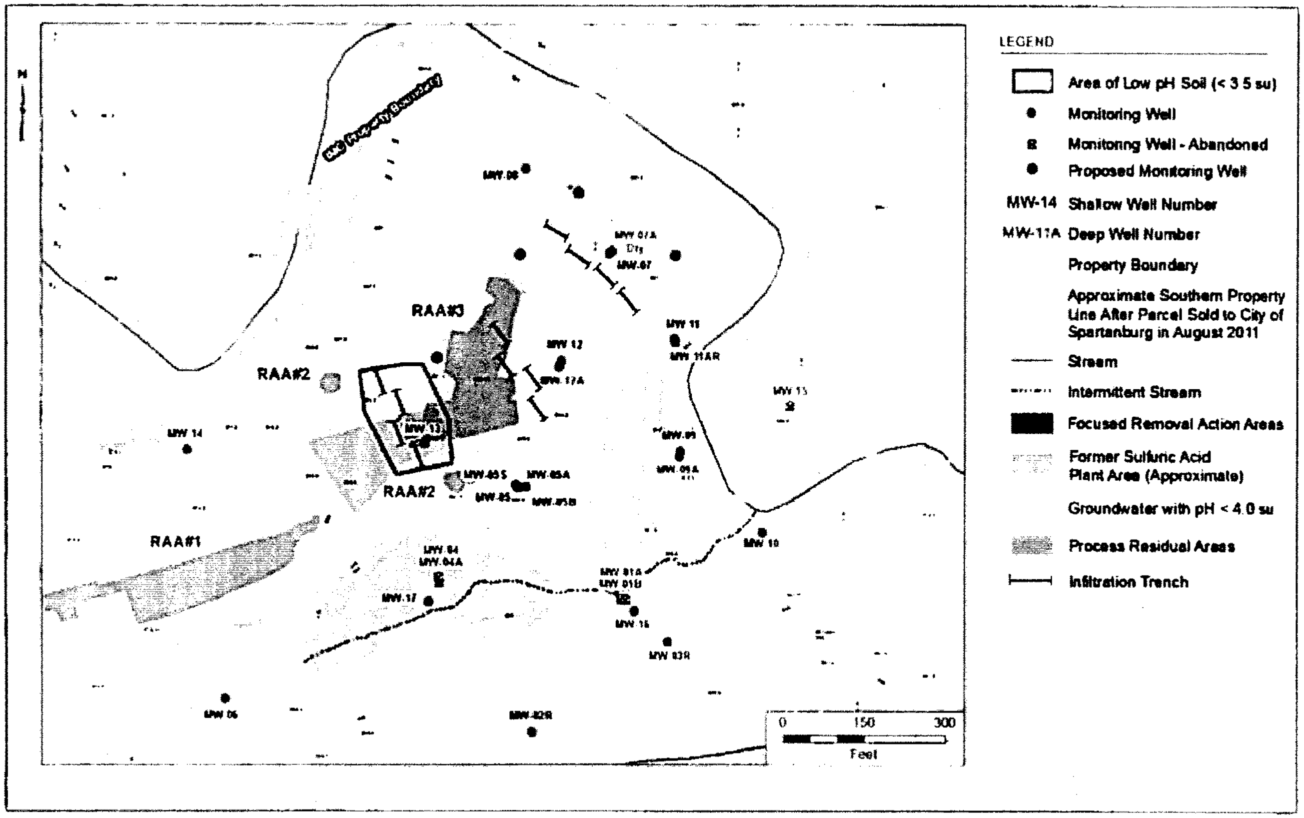


Figure 31
Alternative 2 – Infiltration Galleries

neutralization chemical would begin to neutralize groundwater beneath and downgradient of the infiltration galleries, or, at a minimum, the treated soil would cease to be a continuing source of low pH to the groundwater. The metals present in the affected groundwater above MCLs are the result of native minerals being mobilized by the low pH conditions. Increasing the pH of the groundwater will allow the metals to precipitate from the groundwater flow. Increasing pH is expected to also have a positive effect on fluoride and nitrate concentrations in groundwater. Fluoride is anticipated to bond with existing aluminum and become less soluble in the aquifer as the pH increases. Nitrate is subject to denitrification under favorable geochemical conditions, one of which is a pH near neutral. Fluoride and nitrate are anticipated to attenuate in the affected groundwater area as the effects of the previous removal actions and increasing groundwater pH values become apparent over time.

Eight quarterly infiltration events are proposed for the infiltration galleries within the affected soil area. Four infiltration events are proposed for the downgradient infiltration galleries. The timing of downgradient infiltration events is anticipated to be quarterly, but the timing and distribution of downgradient infiltration will be adjusted as appropriate based on performance monitoring results.

Operation and Maintenance (O&M) Components

O&M components include groundwater monitoring and reporting, inspecting the fence and mowing the site twice a year.

Expected Outcomes

Once continuing sources of low pH to the groundwater have been neutralized, permanent improvement of the downgradient groundwater is expected to occur. Low pH groundwater increases the solubility of metals and causes some naturally occurring metals in soil to dissolve into the groundwater at concentrations exceeding their respective MCLs. When the pH of groundwater in the affected area increases sufficiently, these metals will no longer be present in groundwater above their MCLs. As the pH of groundwater increases, fluoride will bond with the aluminum present in the groundwater to form insoluble compounds. While nitrate is not anticipated to be directly affected by changes in groundwater pH, previous removal actions have removed the sources of nitrates at the Site, so groundwater concentrations will diminish over time. Once the groundwater becomes closer to neutral pH, conditions may become favorable for denitrification.

9.2.3 Alternative 3: Phytoremediation

Estimated Capital Costs:	$492,000
Annual O&M Costs:	$117,600
Total Present Worth Costs:	$2,300,000
Estimated time to construct:	6 months
Estimated time to achieve RAOs:	30 years

Alternative 3 addresses the affected groundwater in the Northeast groundwater area by providing hydraulic containment using a phytoremediation system. This is accomplished by the installation of rows of trees in the downgradient area of the low pH plume. An array of approximately 150 trees in three rows on 10-foot centers is proposed, but subject to revision during RD. Several species of trees (to be determined) will be incorporated into the design. The downgradient portion of the affected groundwater area, along the floodplain of Fairforest Creek, was selected for the phytoremediation system because the water table is located about 10 feet bls and bedrock is located about 20 feet bls – providing reasonable conditions for phytoremediation to be successful. Nearer the source area, the water table is much deeper, making it harder for the root systems of the trees to reach the water table. The trees would be installed using Tree Well® technology that forces the tree roots to reach downward to the affected shallow groundwater. In addition to hydraulic containment provided by transpiration of groundwater, sequestration of metals and neutralizing of pH is anticipated to occur to some extent in the immediate vicinity of the tree roots. **Figure 32** shows the proposed location for phytoremediation.

This alternative does not include additional source material remediation beyond what has already been conducted. However, site-wide performance groundwater monitoring is included in this alternative. Two to four additional wells would be installed to monitor the performance of the phytoremediation system.

Operation and Maintenance (O&M) Components

Once the trees are installed, ongoing inspection will be required. In addition, the Site will be mowed and the fence inspected twice a year. Groundwater monitoring and reporting is also included.

Expected Outcomes

Phytoremediation provides some hydraulic control of the Northeast affected groundwater area via rhizofiltration and phytovolatilization and also provides some removal of constituents in the affected groundwater area via sequestration at the root zone of the trees. Installation of trees to maintain hydraulic control of the low pH plume

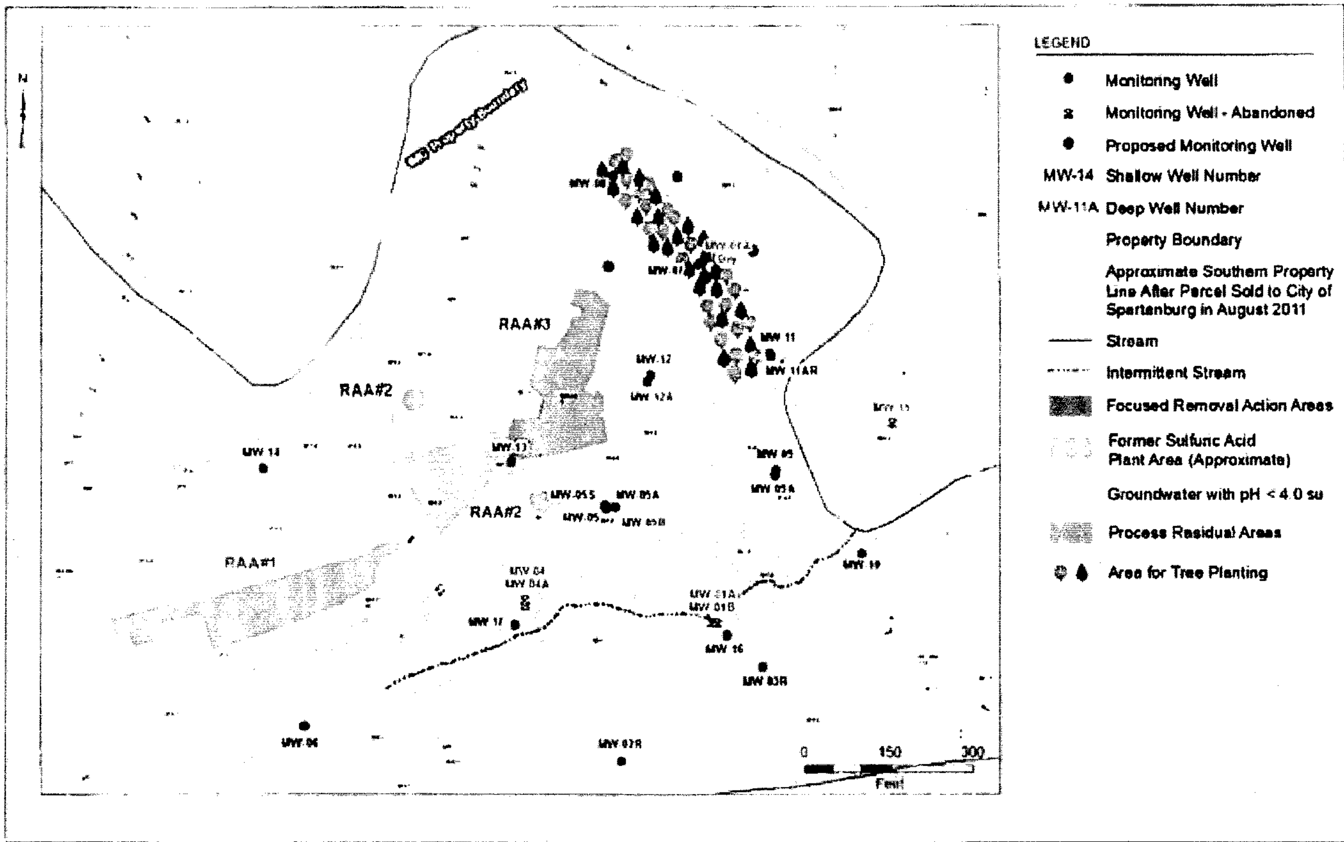


Figure 32
Alternative 3 - Phytoremediation

would effectively mitigate the further downgradient flow of groundwater and would be effective as long as the trees are in place and transpiring. To the extent that sequestration of COCs and neutralizing of pH occurs within the phytoremediation system, these processes would be effective and permanent. When the pH of groundwater in the affected area increases sufficiently by natural flushing, these COCs would no longer be soluble above their MCLs.

9.2.4 Alternative 4: Ex Situ Soil Treatment and Replacement

Estimated Capital Costs:	$4,119,000
Annual O&M Costs:	$100,400
Total Present Worth Costs:	$5,160,000
Estimated time to construct:	6 months
Estimated time to achieve RAOs:	15 years

Alternative 4 includes the excavation and treatment of subsurface low pH soil in the Former Sulfuric Acid Plant area that serves as a continuing source for low pH to the Northeast Area groundwater. To access the affected soil (low pH source material), overburden soil would need to be removed and set aside for later backfilling of the excavation. Additional unaffected soil would also be removed along the excavation sidewalls to create stable, safe slopes. The low pH soil would be mixed with a neutralizing agent. Treatment of the soil would likely occur within the excavation, but the soil would be moved and mechanically mixed during treatment. By neutralizing the low pH source in the subsurface soil, the pH in the underlying and downgradient groundwater would increase. The metals present in the affected groundwater above MCLs are the result of native minerals being mobilized by the low pH conditions.

Increasing the pH of the groundwater will allow the metals to precipitate from the groundwater flow. Increasing pH is expected to also have a positive effect on fluoride and nitrate concentrations in groundwater. Fluoride is anticipated to complex with existing aluminum and become less soluble in the aquifer as the pH increases. Nitrate is subject to denitrification under favorable geochemical conditions, one of which is a pH near neutral. Fluoride and nitrate are anticipated to attenuate in the affected groundwater area as the effects of the previous removal actions and increasing groundwater pH values become apparent over time. **Figure 33** shows the location of the excavation for Alternative 4.

Operation and Maintenance

Annual costs included for this alternative include mowing and inspecting the fence twice a year and groundwater monitoring/reporting.

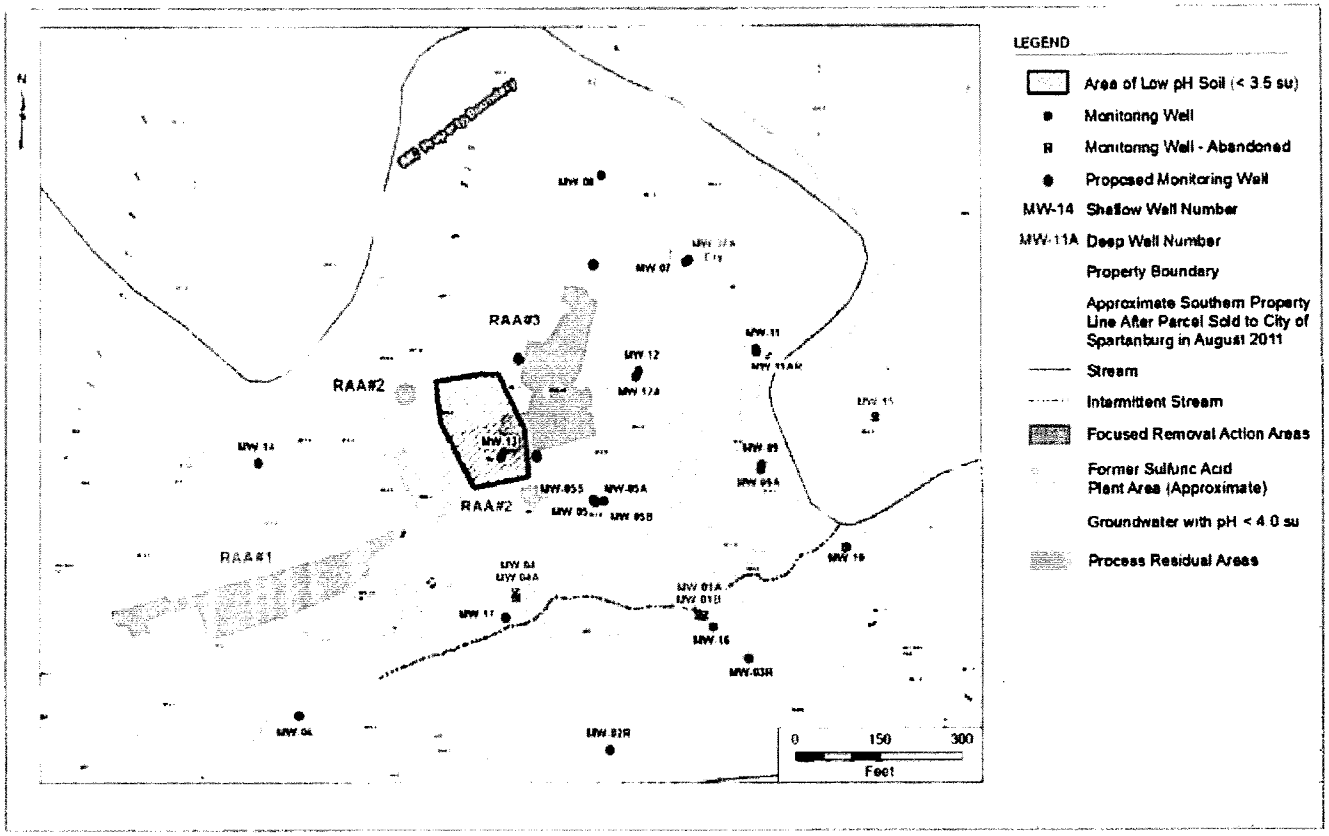


Figure 33
Alternative 4 – Ex Situ Soil Treatment and Replacement

Expected Outcomes

Excavation and treatment of low pH soil with neutralizing chemicals would effectively and permanently treat the source of low pH to affected groundwater, allowing the pH of groundwater to increase over time. Low pH groundwater increases the solubility of metals and causes some naturally occurring metals in soil to dissolve into the groundwater at concentrations exceeding their respective MCLs. When the pH of groundwater in the Northeast groundwater area is sufficiently increased, these metals would no longer be soluble above their MCLs.

9.3 Distinguishing Features

Distinguishing features among the alternatives include:

- Alternatives 2 and 3 are in-situ treatment.
- Alternative 4 addresses soil only.
- Alternative 4 is ex-situ treatment.

9.4 Key ARARs for the Alternatives

Alternative 1 does not have any action-, chemical-, or location-specific ARARs since there are no remedial actions associated with this alternative.

Action-Specific ARARs unique to Alternative 2 include federal underground injection control requirements (40 CFR 144.82(a)(1)) and South Carolina underground injection well operation, monitoring and abandonment requirements applicable to Class V.A. injections wells including "subsurface distribution systems" such as infiltration galleries (SCDHEC R. 61-87).

ARARs common to Alternatives 2, 3 and 4 include RCRA waste characterization, storage and disposal requirements for excavated soils, cuttings from well installation, and/or wastewaters (40 CFR Parts 262, 264, 265, 268 and SCDHEC R. 61-79), and South Carolina monitoring well installation, operation and abandonment requirements (SCDHEC R. 61-71H). These alternatives all involve land disturbance activities and thus must also comply with South Carolina regulatory requirements for managing storm water runoff (SCDHEC R. 61-9, R. 72-307I) and fugitive dust emissions from land disturbing activities (SCDHEC R. 61-62.6 Section III).

Alternatives 2 and 3 pose potential impacts to aquatic systems from land disturbance activities in or near floodplains and/or wetlands and thus must also meet the Location-specific ARARs associated with protection of Fairforest Creek, the floodplain of Fairforest Creek, and the wetlands around Fairforest Creek. These requirements include Clean Water Act ARARs prohibiting the discharge of dredge or fill material into waters of the United States including jurisdictional wetlands (40 CFR 230.10), general conditions in the Nationwide Permit (38) Cleanup of Hazardous and Toxic Waste that are relevant and appropriate to jurisdictional wetlands (33 CFR 323.3(b)), and Executive Orders 11990 and 11988 "to-be-considered" in actions involving potential impacts to, or taking place within, wetlands or floodplains, respectively.

Alternatives 2, 3 and 4 all involve technologies designed to meet the groundwater restoration RAO and thus must satisfy the chemical-Specific ARARs used in developing the Site groundwater cleanup goals, which include SDWA MCLs and the equivalent South Carolina Primary Drinking Water Regulations as set forth in in R.61-58.

10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section of the ROD compares the alternatives against the nine criteria listed in 40 C.F.R. § 300.430(e)(9)(iii) of the NCP, noting how each compares to the other alternatives. A more detailed evaluation of the alternatives against the nine criteria can be found in the FFS. As required, EPA evaluated the alternatives using the nine criteria listed in the NCP. Two of the nine criteria, overall protection of human health and the environment and compliance with ARARs, are threshold criteria. If an alternative does not meet these two criteria, it cannot be considered any further as the Site remedy.

Five of the criteria are balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility, or volume of contaminants through treatment; short-term effectiveness; implementability; and cost. The EPA can make tradeoffs between the alternatives with respect to the balancing criteria.

Two of the criteria are modifying criteria, state/support agency acceptance and community acceptance.

10.1 Overall Protection of Human Health and the Environment

This criterion determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment. This is a threshold criterion.

Migration of low pH source material at the source area through infiltration to groundwater is not addressed in Alternatives 1 and 3. Alternatives 2 and 4 provide source area remediation. Alternative 2 provides source area remediation via infiltration trenches that directly neutralize low pH source material beneath the trenches and groundwater downgradient of the trenches. Alternative 4 provides source area remediation by excavating and directly mixing neutralization chemicals in subsurface soil within the delineated source area. Alternatives 2, 3 and 4 are protective of human health because these alternatives, over time, restore groundwater to be used as a drinking water source. Alternatives 2 through 4 provide institutional controls to ensure the groundwater is not used as a drinking water source until it is restored. Alternatives that include source control are expected to have better protection of human health and the environment because they reduce the time frame for restoration of groundwater.

10.2 Compliance with ARARs

This criterion addresses whether or not a remedy is expected to meet any identified "applicable" or "relevant and appropriate" federal or more stringent state environmental laws or regulations (i.e., ARARs) under CERCLA Section 121(d). Alternatively, it will evaluate whether a waiver of an ARAR can be invoked under CERCLA Section 121(d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those promulgated state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. 40 C.F.R. § 300.5.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Similarly, only those promulgated state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate. 40 C.F.R. § 300.5.

All alternatives except Alternative 1 would be designed to comply with action- and location-specific ARARs. Key ARARs for each alternative are provided in Section 9.4 of this ROD.

10.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of remedial alternatives describes how well an alternative maintains its level of protection of human health and the environment (the first threshold criterion) and its attainment of ARARs (the second threshold criterion) over time.

Long-term effectiveness varies between the alternatives on the basis of completeness and permanence. Alternatives 2, 3, and 4 include institutional controls and performance monitoring until remedial objectives are attained. Alternatives 2 and 4 supplement institutional controls and increase long-term effectiveness because they address the source of low pH materials to groundwater. Alternative 3 supplements institutional controls with some hydraulic control of the affected groundwater and is expected to also provide some in situ treatment of the affected groundwater at downgradient portions of the Northeast groundwater area, but would have a negligible effect on the overall time frame to achieve remedial goals.

10.4 Reduction of Toxicity, Mobility or Volume of Contaminants Through Treatment

Reduction of Toxicity, Mobility or Volume (T/M/V) describes in more detail the mechanism(s) by which each alternative attains the level of protection of human health and the environment (the first threshold criterion) and the attainment of ARARs (the second threshold criterion). The source remediation component of Alternatives 2 and 4 treat or remove low pH materials and further reduce the mobility of COCs. The mobility, toxicity, and volume of affected groundwater are addressed in Alternatives 2 and 3. Alternative 3 is expected to provide some in situ treatment of affected groundwater.

10.5 Short-Term Effectiveness

The short-term effectiveness of remedial alternatives relates to how well an alternative achieves a level of protection of human health and the environment (the first threshold criterion) and attains ARARs (the second threshold criterion) during implementation or installation of the remedial alternative. In some cases, implementation of the alternative could temporarily increase risk and exposure pathways to receptors. Alternative 1 would have little to no adverse short-term effects on the local community. Alternatives 2, 3, and 4 would potentially have a moderate impact on the neighboring residential area because of truck traffic associated with bringing materials onto the site to implement the remedies.

Alternative 1 would have no adverse effects on site workers. Excavations that are potentially a part of Alternatives 2, 3 and 4 have a potential for short-term adverse effects, but these can be controlled by safe construction practices. pH adjusting chemicals to be handled in association with Alternatives 2 and 4 have a potential for short-term adverse effects, but these can be controlled by work practices.

10.6 Implementability

Implementing remedial alternatives involves design, planning, construction or installation, and operation of the various machinery and human components of remedial technologies. The efficiency with which an alternative can be installed and operated impacts how well an alternative achieves its level of protection (the first threshold criterion) and attains ARARs (the second threshold criterion). In some cases, implementation of the alternative could be technically difficult or impossible given site-specific limitations. The No Action alternative is the simplest alternative to implement.

None of the alternatives have significant implementability issues. Alternative 3, which includes installation of downgradient treatment components, may require consideration of floodplain/wetland issues. Alternative 2 may require an UIC permit to apply neutralizing/buffering agents at the low pH source area via an infiltration trench. Phytoremediation included in Alternative 3 could be adversely impacted by low pH if pH adjustments are not made in the localized area.

10.7 Cost

This criterion evaluates the estimated capital and O&M costs as well as present worth costs. Present worth costs are the total costs of an alternative over time in terms of today's dollars (i.e., present worth costs correct for expected inflation). The cost estimates are expected to be accurate within a range of +50 to -30 percent.

The costs for Alternatives 2 through 4 are based upon the various construction costs (capital costs), O&M costs that are required for implementation, and groundwater monitoring and reporting costs. Alternative 1 has no cost associated with it because no actions are taken. The capital cost associated with implementing Alternative 3 is low compared to Alternatives 2 and 4, but that alternative does not address the source of low pH to groundwater. Therefore, the duration of Alternative 3 is longer and the total present worth is higher relative to Alternative 2. Of the alternatives that address the source of low pH to groundwater, Alternative 2 has a significantly lower overall cost compared to Alternative 4.

10.8 State/Support Agency Acceptance

This criterion considers whether the state agrees with the EPA's analyses and recommendations of the RI/FS and the Proposed Plan. This is a modifying criterion. The SC DHEC supports the EPA's selection of Alternative 2 for site remediation.

10.9 Community Acceptance

This criterion considers whether the local community agrees with the EPA's analyses and preferred alternative. Comments received on the Proposed Plan are important indicators of community acceptance. This is a modifying criterion. The Proposed Plan Fact Sheet was mailed to the public prior to the commencement of the public comment period which ran from June 9 to July 9, 2014. The notice of the availability of project documents was published in the Spartanburg Herald on June 10, 2014. The public meeting was held on June 26, 2014.

10.10 Summary of the Comparative Analysis

Based on the comparative analysis above, Alternative 2 is the best alternative for the IMC Site. It addresses the low pH soil and the low pH groundwater both at the source and downgradient. It is relatively safe, cost-effective, and easily implemented.

11.0 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site, whenever practicable. 40 C.F.R. §300.430(a)(1)(iii). Principal threat wastes are source materials that are considered highly toxic or highly mobile, that cannot be reliably contained, or present a significant risk to human health or the environment. The IMC Site does not contain principal threat wastes.

Low pH soils (less than 3.5 s.u.) decrease with depth with the lowest values found greater than 10 feet bls, generally extending vertically to the groundwater table. pH does not have a risk based target, however low pH soil causes low pH water which in turn mobilizes naturally occurring metals from native soil at concentrations above the groundwater cleanup levels. The low pH soils are located in the former sulfuric acid area. This area is considered to be the primary source of metals impacts to groundwater at the IMC Site.

The selected remedy satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduce the toxicity, mobility, or volume of hazardous substances through treatment) since the low pH soil is being treated.

12.0 SELECTED REMEDY

Alternative 2, the selected remedial alternative for the IMC Site, will address the contaminated groundwater and the low pH soil at the Site. It provides for in-situ treatment of the soil and groundwater that contains contaminants above the cleanup levels. ICs will be implemented to specifically restrict future withdrawal of groundwater from the IMC Site until it is restored.

Alternative 2 meets the threshold criteria, protection of human health and the environment and compliance with ARARs. It also provides the best balance among the balancing criteria and meets the acceptance of the state (SC DHEC) and the community.

12.1 Summary of the Rationale for the Selected Remedy

Alternative 2 was chosen because of the combination of ease of implementation, good results from the NTCRA, and treatment of contamination in-situ. Alternative 2 meets both the threshold criteria - protection of human health and the environment and compliance with ARARs. It also provides the best balance among the balancing criteria and meets the acceptance of the state (SC DHEC) and the community.

12.2 Description of the Selected Remedy

The following is a description of the Selected Remedy. Although the EPA does not expect significant changes to this remedy, it may undergo minor changes as a result of the remedial design and construction processes. Any changes to the remedy described in this ROD would be documented using a technical memorandum in the Administrative Record, an Explanation of Significant Differences (ESD) or a ROD amendment, as appropriate and consistent with the NCP and with EPA policy and guidance.

12.2.1 Cleanup Levels

The hypothetical groundwater future ingestion pathway was the only pathway in the HHRA with potential risks/hazards above EPA target range. The cleanup levels are based on the chemical-specific ARARs (e.g., MCLs or non-zero MCLGs). **See Table 21** for a complete list of groundwater cleanup levels.

12.2.2 Volume of Contamination Requiring Remediation

The low pH source area in the Former Sulfuric Acid Plant area is estimated to be approximately 31,700 cubic yards. This volume is based on information obtained during the October 2013 low pH soil evaluation described previously. The delineation of affected source material will be refined during the RD.

The affected groundwater area addressed in this ROD is shown in **Figure 34**. Assuming a saturated thickness ranging from 10 to 25 feet and a porosity of 0.3, the volume of potentially affected groundwater, as delineated in Figure 34, is estimated to range from 17 to 44 million gallons.

12.2.3 Components of the Selected Remedy

The selected remedy for source remediation is infiltration galleries, groundwater monitoring and ICs to achieve cleanup levels at the IMC Site.

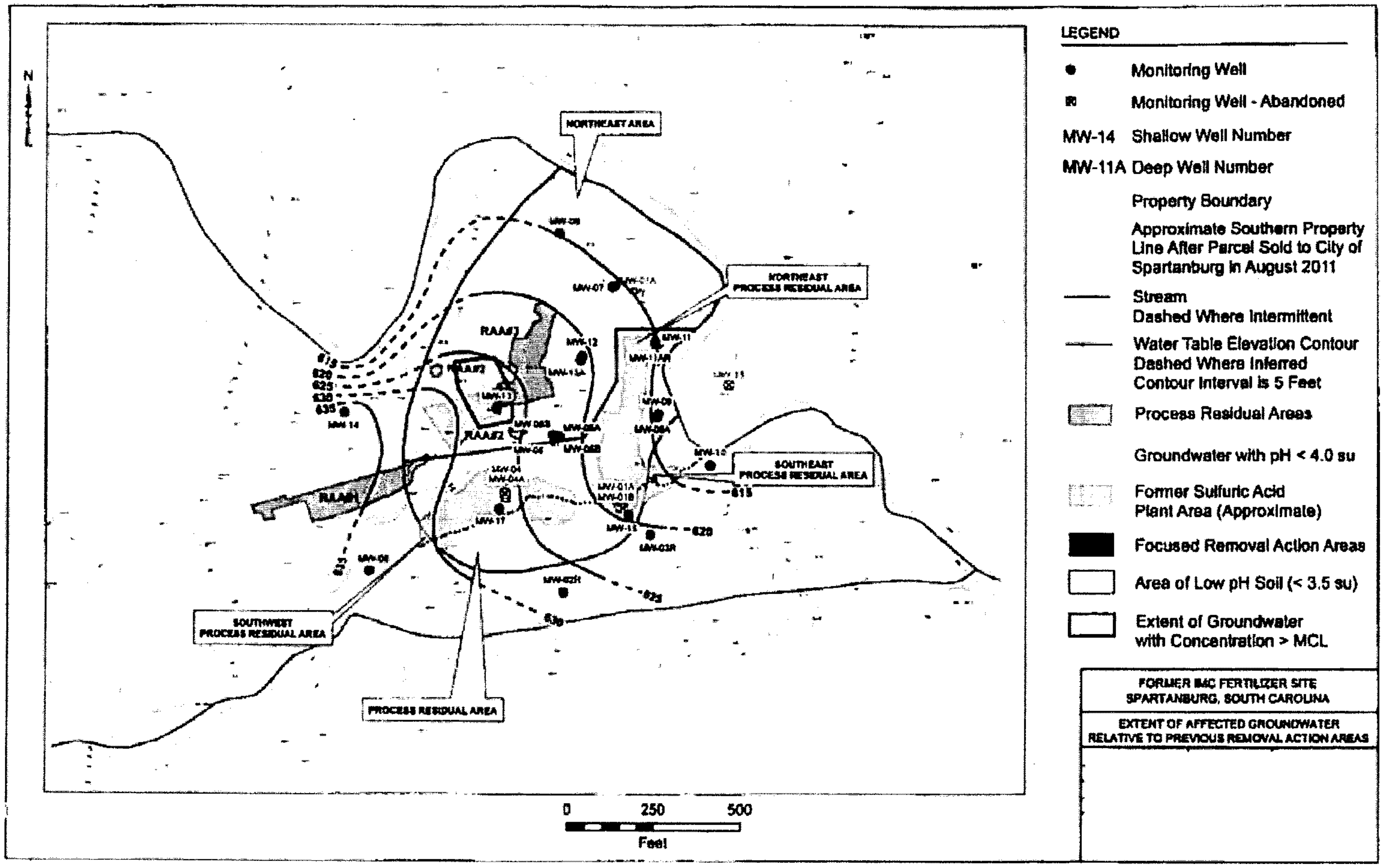

LEGEND
Monitoring Well
Monitoring Well - Abandoned
MW-14 Shallow Well Number
MW-11A Deep Well Number
Property Boundary
Approximate Southern Property Line After Parcel Sold to City of Spartanburg in August 2011
Stream
Dashed Where Intermittent
Water Table Elevation Contour
Dashed Where Inferred
Contour Interval is 5 Feet
Process Residual Areas
Groundwater with pH < 4.0 su
Former Sulfuric Acid Plant Area (Approximate)
Focused Removal Action Areas
Area of Low pH Soil (< 3.5 su)
Extent of Groundwater with Concentration > MCL
FORMER IMC FERTILIZER SITE
SPARTANBURG, SOUTH CAROLINA
EXTENT OF AFFECTED GROUNDWATER RELATIVE TO PREVIOUS REMOVAL ACTION AREAS
NORTHEAST AREA
NORTHEAST PROCESS RESIDUAL AREA
SOUTHEAST PROCESS RESIDUAL AREA
SOUTHWEST PROCESS RESIDUAL AREA
PROCESS RESIDUAL AREA
N
0
250
500
Feet

Figure 34

The components of the selected remedy are:

- Installation of a series of infiltration galleries. Each gallery will be constructed of perforated 2-foot diameter pipe laid horizontally at a depth of 8 to 10 feet bls. The infiltration galleries are proposed to be arrayed in three rows. The first row is located within the affected soil area. The second row is located about one-third the distance from the affected soil area to Fairforest Creek. The third row is located about half the distance from the second row to Fairforest Creek.

- Each pipe would be filled with a neutralizing chemical solution such as sodium carbonate. The chemical would drain by gravity from the pipe, neutralizing underlying soil. Over time, the infiltrated neutralization chemical would begin to neutralize groundwater beneath and downgradient of the infiltration galleries, or, at a minimum, the treated soil would cease to be a continuing source of low pH to the groundwater.

- Eight quarterly infiltration events are proposed for the infiltration galleries within the affected soil area. Four infiltration events are proposed for the downgradient infiltration galleries. The timing of downgradient infiltration events is anticipated to be quarterly, but the timing and distribution of downgradient infiltration will be adjusted as appropriate based on performance monitoring results.

- Institutional controls for site-wide groundwater use restrictions will be kept in place until constituent concentrations in groundwater are at or below MCLs. In addition to the institutional controls, engineered controls such as the existing security fencing would be maintained to limit access to the Site.

- Periodic performance groundwater monitoring would be conducted as part of this remedy. Performance monitoring would include a baseline sampling event just prior to implementing the remedy and semiannual groundwater monitoring following implementation. If monitoring data suggest, after a reasonable record has been established, that less frequent monitoring is appropriate, then the monitoring frequency will be reduced. Two to four additional groundwater monitoring wells are proposed to monitor the performance of this remedy.

- On an annual basis, an upstream and downstream surface water sample will be collected from Fairforest Creek to confirm that water quality is maintained.

- In the Process Residual groundwater area, source material has been removed, limestone placed in the excavations prior to backfilling to provide buffering to the low pH groundwater and remediation of groundwater is occurring. Performance groundwater monitoring will be conducted in this area also.

The goal of the remedial action is to restore the groundwater to its beneficial use within a reasonable time frame. Until this goal is achieved, ICs will be implemented to prevent human exposure to contaminated groundwater. Public water is available in the area and is supplied from municipal wells.

12.3 SUMMARY OF THE ESTIMATED REMEDY COSTS

Table 22 provides line item costs used in the cost estimate. This estimate is expected to be within +50% and -30% of the actual costs of the remedy. The remedy is estimated to cost $2.19 million.

Table 22 - Alternative 2 Present Worth Cost Estimate

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	SUBTOTAL	TOTAL
CAPITAL COSTS					
Source Remediation					
Mobilization	1	L.S.	31,000	31,000	
Site Preparation/Restoration	1	L.S.	129,000	129,000	
Trenching	1	L.S.	370,000	370,000	
Demobilization	1	L.S.	20,000	20,000	
Chemical Fill	1	L.S.	240,000	240,000	
					$790,000
Wells and IC					
Engineering Plan and IC Document	1	L.S.	20,000	20,000	
Monitoring Wells	4	well	6,500	26,000	
					$46,000
Permitting/Design/Consulting				83,600	
Contingency (25%)				229,900	
			Total Capital Costs		$1,150,000
O&M COSTS					
Mow 2 times a year				6,400	
Inspect fence 2 times a year				2,000	
Groundwater monitoring and reporting				92,000	
	Total Annual Costs		$100,400 (15 year present worth)		$1,042,152
				Total Cost for Remedy	**$2,190,000**

12.4 EXPECTED OUTCOME OF THE SELECTED REMEDY

The expected outcome of the selected remedy is the restoration of the groundwater that will allow for its unrestricted use. Groundwater is affected by contaminants from this Site. Groundwater flows toward and discharges into surface water, however, RI sampling revealed little impact. The ecological risk assessment concluded that the risks were negligible and no further ecological investigation was warranted. **Table 23** summarizes the cleanup levels and the risks when cleanup levels are achieved.

Table 23 - Cleanup Levels and Associated Risk

CHEMICAL OF CONCERN	Groundwater Cleanup Levels (ug/L)	Basis	Risk at Cleanup Level[1]	
			Risk	HQ
Beryllium	4	MCL	2.2 E-4	0.05
Cadmium	5	MCL	NC	0.27
Lead	15	Federal Action Level	NC	NC
Thallium	2	MCL	NC	NC
Fluoride	4,000	MCL	NC	1.8
Nitrate	10,000	MCL	NC	0.17
Benzene	5	MCL	3.23 E-6	0.03
2,4-DNT	10	RL	8.0 E-5	0.1

ug/L - Micrograms per liter MCL - EPA Maximum Contaminant Level
RL – Laboratory reporting limit
NC – Not calculated due to absence of published slope factor and/or reference dose
[1] – Risk calculated based on hypothetical future residential use of groundwater as the sole potable source of water. This exposure pathway is not a completed pathway at this Site.

13.0 STATUTORY DETERMINATIONS

13.1 Protection of Human Health and the Environment

This remedy protects human health and the environment by neutralizing low pH source material that acts as a continuing source of low pH to the groundwater and by neutralizing groundwater downgradient of the source area. As the continuing source is depleted, natural processes, over time, will restore groundwater quality. Performance monitoring allows the progress of this remedy to be tracked. Existing monitoring wells are located just downgradient of the three proposed lines of infiltration galleries. Two to four additional monitoring wells will improve the distribution of monitoring locations for this remedy. Institutional and engineering controls would be used to protect human health and the environment in the short term while treatment and natural processes are underway. The exceedances of metals MCLs in the affected groundwater area are the result of natural formation constituents being mobilized by low pH conditions. pH adjustment is expected to have a positive effect on fluoride and nitrate concentrations in groundwater. Fluoride is anticipated to combine with existing aluminum and become less soluble in the aquifer as the groundwater pH increases. Nitrate is subject to denitrification under favorable geochemical conditions, one of which is a pH near neutral. Fluoride and nitrate are anticipated to attenuate in the affected groundwater area as the effects of the previous removal actions and neutralization become apparent over time. Although affected groundwater is unlikely to be consumed under any reasonably anticipated future land use, institutional controls would ensure that supply wells are not installed in the affected area until constituent concentrations in groundwater are at or below MCLs.

13.2 Compliance with Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA, as amended, specifies in part, that remedial actions for cleanup of hazardous substances must comply with requirements and standards under federal or more stringent state environmental laws and regulations that are applicable or relevant and appropriate (i.e., ARARs) to the hazardous substances or particular circumstances at a site unless such ARAR(s) are waived under CERCLA Section 121(d) (4). See also 40 C.F.R. § 300.430(f)(1)(ii)(B). ARARs include only federal and state environmental or facility siting laws/regulations and do not include occupational safety or worker protection requirements. Compliance with OSHA standards is required by 40 C.F.R. § 300.150 and therefore the CERCLA requirement for compliance with or wavier of ARARs does not apply to OSHA standards.

Under CERCLA Section 121(e)(1), federal, state, or local permits are not required for the portion of any removal or remedial action conducted entirely 'on-site' as defined in 40 C.F.R. § 300.5. See also 40 C.F.R. §§ 300.400(e)(1) & (2). Also, CERCLA response actions must only comply with the "substantive requirements," not the administrative requirements of a regulation or law. Administrative requirements include permit applications, reporting, record keeping, inspections, and consultation with administrative bodies. Although consultation with state and federal agencies responsible for issuing permits is not required, it is often recommended for determining compliance with certain requirements such as those typically identified as Location-Specific ARARs. See EPA, OSWER Directives No. 9234.1-01 and 9234.1-02, CERCLA Compliance with Other Laws Manual: Parts 1 and Part II (August 1988 and 1989).

Applicable requirements, as defined in 40 C.F.R. § 300.5, means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, or contaminant, remedial action, location, or other circumstance at a CERCLA site. Only those state standards that are identified by the state in a timely manner and that are more stringent than federal requirements may be applicable. Relevant and appropriate requirements, as defined in 40 C.F.R. § 300.5, means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, or contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by the state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate.

Per 40 C.F.R. § 300.400(g)(5), only those state standards that are promulgated, are identified in a timely manner, and that are more stringent than federal requirements may be applicable or relevant and appropriate. For purposes of identification and notification of promulgated state standards, the term promulgated means that the standards are of general applicability and are legally enforceable. State ARARs are considered more stringent where there is no corresponding federal ARAR, where the State ARAR provides a more stringent concentration of a contaminant, or the where a State ARAR is broader in scope than a federal requirement. See EPA, OSWER Pub. No. 9234.2-05/FS, CERCLA Compliance with State Requirements (December 1989).

In addition to ARARs, the lead and support agencies may, as appropriate, identify other advisories, criteria, or guidance to be considered for a particular release that may be useful in developing Superfund remedies. See 40 C.F.R. § 300.400(g)(3). The "to-be-considered" (TBC) category consists of advisories, criteria, or guidance that were developed by EPA, other federal agencies, or states that may assist in determining, for example health-based levels for a particular contaminant for which there are no ARARs or the appropriate method for conducting an action. TBCs are not considered legally enforceable and, therefore, are not considered to be applicable for a site but typically are evaluated along with Chemical-specific ARARs as part of the risk assessment to determine protective cleanup levels. See EPA, OSWER Directives No. 9234.1-01 and 9234.1-02, CERCLA Compliance with Other Laws Manual: Parts 1 and Part II (August 1988 and 1989), Section 1.4.

In accordance with 40 C.F.R. § 300.400(g), EPA and the State of South Carolina have identified the potential ARARs and TBCs for the evaluated alternatives. **Tables 24, 25, and 26** lists respectively the Chemical-, Action, and Location-Specific ARARs/TBCs for the selected remedial alternative.

ARAR Categories
For purposes of ease of identification, the EPA has created three categories of ARARs: Chemical-, Location- and Action-Specific. Under 40 C.F.R. § 300.400(g)(5), the lead and support agencies shall identify their specific ARARs for a particular site and notify each other in a timely manner as described in 40 C.F.R. § 300.515(d). Chemical-, and Location-Specific ARARs should be identified as early as scoping phase of the Remedial Investigation, while Action-Specific ARARs are identified as part of the Feasibility Study for each remedial alternative. See 40 C.F.R. §§ 300.430(b)(9) & 300.430(d)(3).

Action-Specific ARARs/TBC Guidance
Action-specific ARARs are usually technology-based or activity-based requirements or limitations that control actions taken at hazardous waste sites. Action-Specific requirements often include performance, design and controls, or restrictions on

particular kinds of activities related to management of hazardous substances. Action-specific ARARs are triggered by the types of remedial activities and types of wastes that are generated, stored, treated, disposed, emitted, discharged, or otherwise managed. **Table 25** lists the potential Action-Specific ARARs for the remedial action, including RCRA waste characterization, storage and disposal requirements (from 40 CFR Parts 262, 264, 265, 268 and SCDHEC R. 61-79), federal underground injection control requirements (40 CFR 144.82(a)(1)), South Carolina underground injection well operation, monitoring and abandonment requirements applicable to Class V.A. injection wells including "subsurface distribution systems" such as infiltration galleries (SCDHEC R. 61-87), South Carolina monitoring well installation, operation and abandonment requirements (SCDHEC R. 61-71H). During installation of the underground infiltration galleries, overburden soil will be excavated and then replaced above the infiltration galleries. Soil cuttings will also be generated if additional monitoring wells are required. While it is anticipated that the soil cuttings and overburden soil will be non-hazardous, the soils will be tested and managed in accordance with RCRA waste characterization, storage and disposal requirements, as necessary. The remedial action must also comply with South Carolina regulatory requirements for managing storm water runoff (SCDHEC R. 61-9, R. 72-307I) and fugitive dust emissions from land disturbing activities (SCDHEC R. 61-62.6 Section III).

Chemical-Specific ARARs/TBC Guidance

Chemical-Specific ARARs are usually health or risk based numerical values limiting the amount or concentration of a chemical that may be found in, or discharged to, the environment. The Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) at 40 C.F.R. Part 141 and the state or federal ambient water quality criteria established under Section 303 or 304 of the Clean Water Act are examples of Chemical-Specific ARARs used to establish remediation levels for restoration of groundwater that are current or potential sources of drinking water and restoration of surface water to meet its designated uses or classifications, respectively. See 40 C.F.R. §§ 300.430(e)(2)(i)(B), (C), & (E).

Table 24 lists the Chemical-Specific ARARs for the Site, which includes SDWA MCLs and the equivalent South Carolina Primary Drinking Water Regulations as set forth in in R.61-58. All inorganic and organic contaminants in underground sources of drinking water may not exceed the MCLs. In addition, the requirements in 40 CFR 141.80(a) Subpart I, known as the "lead and copper rule," establish the federal action level for lead. Lead concentrations in groundwater must not exceed 0.015 mg/L.

Location-Specific ARARs/TBC Guidance

Location-Specific requirements establish restrictions on permissible concentrations of hazardous substances or establish requirements for how activities will be conducted because they are in special locations (e.g., wetlands, floodplains, critical habitats,

Table 24 - Chemical-Specific ARARs, Former IMC Fertilizer Site

Action/Media	Requirements	Prerequisite	Citation(s)
Classification of ground water	All South Carolina groundwater is classified Class GB under SCDHEC R. 61-68H.9, which meets the definition of underground sources of drinking water.	Groundwater, except within mixing zones, within the state of South Carolina – **applicable**	SCDHEC Reg. 61-68H.2
Restoration of ground water as a potential drinking water source	All inorganic and organic contaminants in underground sources of drinking water may not exceed Maximum Contaminant levels (MCLs) as set forth in R.61-58, State Primary Drinking Water Regulations. Site Contaminants of Concern: Arsenic 0.01 mg/L Beryllium 0.004 mg/L Cadmium 0.005 mg/L Selenium 0.05 mg/L Thallium 0.002 mg/L Fluoride 4.0 mg/L Nitrate 10.0 mg/L Benzene 0.005 mg/L	Groundwater classified as underground source of drinking water (USDW) as (defined in SCDHEC Reg. 61-68B.62) – **relevant and appropriate**	SCDHEC Reg. 61-68H.9.b 40 CFR Part 141 Subpart G (*National Primary Drinking Water Regulations)*
	The requirements of this Subpart I constitute the national primary drinking water regulations for lead. The lead action level is exceeded if the concentration of lead is greater than 0.015 mg/L.	Groundwater classified as underground source of drinking water – **relevant and appropriate**	40 CFR 141.80(a) 40 CFR 141.80(c)(1)
	Shall not exceed concentrations or amounts such as to interfere with use, actual or intended, as determined by SCDHEC.	Presence of waste, pesticides, other synthetic organic compounds, deleterious substances, or constituents thereof not specified in SCDHEC R. 61-68H.9a or b. in Class GB groundwater – **relevant and appropriate**	SCDHEC R. 61-68H.9.c

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
General Construction Standards — All Land-disturbing Activities (i.e., excavation, clearing, grading, etc.)			
Managing storm water runoff from land-disturbing activities	Must comply with the substantive requirements for stormwater management and sediment control of *NPDES Construction General (CG) Permit for Stormwater Discharges No. SCR100000, issued under R.122.8 and developed consistent with the conditions in R.61-9.122.41 applicable to all permits.*	Large and small construction activities (as defined in R. 61-9 and SCR100000) of more than 1 acre of land – **applicable**	SCDHEC R. 61-9.122.41 and 122.28(a)(2)(i)
	Coverage under the CG Permit requires development of a stormwater management and sediment control plan which is to be consistent, at a minimum, to the substantive standards listed in SC Regulation 72-300, unless specifically exempted by SC Regulation 72-302.A Note: The stormwater and sediment control plan will be included in an appropriate EPA-approved CERCLA RD/RA document.	Large and small construction activities (as defined in R. 61-9 and SCR100000) of more than 1 acre of land – **TBC**	*NPDES Construction General (CG) Permit for Stormwater Discharges,* Permit No. SCR100000
	The stormwater management and sediment control plan shall contain at a minimum the information provided in the following subsections: • A plan for temporary and permanent vegetative and structural erosion and sediment control measures which specify the erosion and sediment control measures to be used during all phases of the land disturbing activity and a description of their proposed operation; • Provisions for stormwater runoff control during the land disturbing activity and during the life of the facility meeting the peak discharge rate and velocities requirements in subsections (e)1. and (e)2. of this section.	Activities involving more than two (2) acres and less than five (5) acres of actual land disturbance which are not part of a larger common plan of development or sale – **applicable**	SCDHEC R. 72-307I(3)(d) and (e) – *South Carolina Storm Water Management and Sediment Reduction Regulations*
Managing fugitive dust emissions from land disturbing activities	Emissions of fugitive particulate matter shall be controlled in such a manner and to the degree that it does not create an undesirable level of air pollution. Volatile organic compounds shall not be used for dust control purposes. Oil treatment is also prohibited.	Activities that will generate fugitive particulate matter (Statewide) – **applicable**	SCDHEC R. 61-62.6 Section III(a)- *Control of Fugitive Particulate Matter Statewide* SCDHEC R. 61-62.6 Section III(d)

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
Monitoring Well Installation, Operation, and Abandonment			
Installation of Permanent and Temporary Monitoring Wells	All monitoring wells shall be drilled, constructed, maintained, operated, and/or abandoned to ensure that underground sources of drinking water are not contaminated.	Construction of permanent and temporary monitoring wells, as defined in R. 61-71B – **applicable**	SCDHEC R. 61-71H.1(b)
Installation of Permanent Conventionally Installed or Direct Push Monitoring Wells	Wells shall be grouted from the top of the bentonite seal to the land surface. Grout is to be composed of neat cement, a bentonite cement mixture, or high solids sodium bentonite grout.	Construction of permanent conventionally installed or direct push monitoring wells, as defined in R. 61-71B – **applicable**	SCDHEC R. 61-71H.2.a.(1),(2) *[conventionally installed wells]* SCDHEC R. 61-71H.3.b.(1),(2) *[direct push wells]*
	The diameter of the annular space shall be large enough to allow for forced injection of grout through a tremie pipe. All grouting shall be accomplished using forced injection to emplace the grout. When emplacing the grouting material, the tremie pipe shall be lowered to the bottom of the zone to be grouted. The tremie pipe shall be kept full continuously from start to finish of the grouting procedure, with the discharge end of the tremie pipe being continuously submerged in the grout until the zone to be grouted is completely filled.		SCDHEC R. 61-71H.2.a.(3),(4) *[conventionally installed wells]* SCDHEC R. 61-71H.3.b.(3),(4) *[direct push wells]*
	A cement or aggregate reinforced concrete pad at the ground surface of appropriate durability and strength, considering the setting and location of each well, that extends six inches beyond the borehole diameter and six inches below ground surface is required. The pad shall be capable of preventing infiltration between the surface casing and the borehole to the subsurface.		SCDHEC R. 61-71H.2.a.(5) *[conventionally installed wells]* SCDHEC R. 61-71H.3.b.(5) *[direct push wells]*

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
Installation of Permanent Conventionally Installed or Direct Push Monitoring Wells (cont'd)	Well Construction and Materials Standards – (1) Casing shall be of sufficient strength to withstand normal forces encountered during and after well installation and be composed of material so as to minimally affect water quality analyses. (2) Casing shall have a sufficient diameter to provide access for sampling equipment. (3) A properly hydrated bentonite seal with a minimum thickness of twelve inches directly above the filter pack shall be used, if the well has a filter pack. (4) The monitoring well intake or screen design shall minimize formational materials from entering the well. The filter pack 17 shall be utilized opposite the well screen as appropriate in so that parameter analyses will be minimally affected. (5) A locking cap or other security devices to prevent damage and/or vandalism shall be used. (6) Monitoring wells completed below grade shall be in a watertight vault with a well cap to prevent infiltration of surface water into the well.	Construction of permanent conventionally installed or direct push monitoring wells, as defined in R. 61-71B – **applicable**	SCDHEC R. 61-71H.2.b. *[conventionally installed wells]* SCDHEC R. 61-71H.3.c *[direct push wells]*
	All monitoring wells shall be properly labeled with an identification plate immediately upon well completion. The identification plate shall be constructed of a durable, weatherproof, rustproof, material. The identification plate shall be permanently secured to the well casing or enclosure floor around the casing where it is readily visible and shall identify: (1) company name and certification number of the driller who installed the well; (2) date well was completed; (3) total depth (feet); (4) casing depth (feet); (5) screened Interval; (6) designator and/or identification number.		R. 61-71H.2.c. *[conventionally installed wells]* SCDHEC R. 61-71H.3.d *[direct push wells]*
Additional Requirements for Installation of Direct Push Monitoring Wells	Direct push wells cannot be installed below a confining layer unless it can be demonstrated to the satisfaction of the Department that cross-contamination of the aquifer systems can be prevented.	Construction of direct push monitoring wells, as defined in R. 61-71B – **applicable**	R. 61-71H.3.a.

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
Installation of Temporary Monitoring Wells	Construction and Materials – (1) Casing shall be of sufficient strength to withstand normal forces encountered during and after well installation and be 20 composed of material so as to minimally affect water quality analyses. (2) Casing shall have a sufficient diameter to provide access for sampling equipment. (3) The monitoring well intake or screen design shall minimize formational materials from entering the well. The filter pack or intake shall be utilized opposite the well screen as appropriate so that parameter analyses will be minimally affected.	Construction of temporary monitoring wells, as defined in R. 61-71B – **applicable**	SCDHEC R. 61-71H.4.a.
	All temporary monitoring wells shall be sealed with a watertight cap or seal until abandoned. Temporary monitoring wells shall be maintained such that they are not a source or channel of contamination before they are abandoned.	Operation and maintenance of temporary monitoring wells, as defined in R. 61-71B – **applicable**	SCDHEC R. 61-71H.4.b.
Abandonment of Permanent Conventionally Installed Monitoring Wells	Abandonment of permanent conventionally installed monitoring wells shall be by forced injection of grout or pouring through a tremie pipe starting at the bottom of the well and proceeding to the surface in one continuous operation. The well shall be filled with either with neat cement, bentonite-cement, or 20% high solids sodium bentonite grout, from the bottom of the well to the land surface.	Abandonment of permanent conventionally installed monitoring wells – **applicable**	SCDHEC R. 61-71H.2.e.

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
Abandonment of Permanent Direct Push Monitoring Wells	(1) Permanent direct push wells that do not penetrate a confining layer shall be abandoned by removing all casing from the subsurface and be grouted by forced injection through a tremie pipe from the total depth to the land surface, or by forced injection or pouring of neat cement, bentonite-cement, or 20% high solids sodium bentonite grout through a tremie pipe starting at the bottom of the well and proceeding to the surface. (2) Direct push wells that penetrate a confining layer shall be abandoned by forced injection or pouring of neat cement, bentonite-cement, or 20% high solids sodium bentonite grout through a tremie pipe starting at the bottom of the well and proceeding to the surface in one continuous operation.	Abandonment of permanent direct push monitoring wells, as defined in R.61-71B – **applicable**	SCDHEC R. 61-71H.2.f.

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
Abandonment of Temporary Conventionally Installed or Direct Push Monitoring Wells	(1) All temporary monitoring wells shall be abandoned within 5 days of borehole completion. (2) A conventionally drilled temporary well shall be abandoned by forced injection of neat cement, bentonite-cement, or 20% high solids sodium bentonite grout through a tremie pipe starting at the bottom of the well and proceeding to the surface in one continuous operation. (3) A temporary direct push well that does not penetrate a confining layer shall be abandoned by forced injection of neat cement, bentonite-cement, or 20% high solids sodium bentonite grout through a tremie pipe after the sampling device has been removed. (4) A temporary direct push well that penetrates a confining layer shall be abandoned by forced injection of neat cement, bentonite-cement, or 20% high solids sodium bentonite grout through the sampling device as the sampling device is removed from the sub-surface. Abandonment shall occur during the initial withdrawal from the original push borehole and not by a separate tremie tool after the sampling device has been removed to ensure the breech in the confining layer is permanently sealed.	Abandonment of temporary conventionally installed or direct push monitoring wells, as defined in R.61-71B – **applicable**	SCDHEC R. 61-71H.4.c.
Underground Infiltration Galleries - Installation, Operation, and Abandonment			
Injection of reagents through underground infiltration galleries	An injection activity cannot allow the movement of fluid containing any contaminant into USDWs, if the presence of that contaminant may cause a violation of the primary drinking water standards under 40 CFR part 141, other health based standards, or may otherwise adversely affect the health of persons. This prohibition applies to well construction, operation, maintenance, conversion, plugging, closure, or any other injection activity.	Class V wells [as defined in 40 CFR 144.6(e)] used to inject reagents – **applicable**	40 CFR 144.82(a)(1)
	The movement of fluids containing wastes or contaminants into underground sources of drinking	Operation of wells, including subsurface fluid distribution systems, as defined in	SCDHEC R.61-87.5

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
	water as a result of injection is prohibited if the presence of the waste or contaminant: • May cause a violation of any drinking water standard under R61-58.5; or, • May otherwise adversely affect the health of persons.	R. 61-87.2(Z), for underground injection of any fluids into the subsurface or ground waters of the State of South Carolina – **applicable**	
	No person shall construct, use or operate a Class V.A. well for injection in violation of R61-87.5.	Class V.A injection wells [as classed in R.61-87.11(E)(1)(g)], including subsurface fluid distribution system [as defined in 87.2(Z)] for use in experimental technologies – **applicable**	SCDHEC R.61-87.11(E)(2)(b)
Operation of underground infiltration galleries	At a minimum, the following information concerning the injection formation shall be determined or calculated: (1) Fluid pressure; (2) Estimated fracture pressure; (3) Physical and chemical characteristics of the injection zone. Note: Depending upon how the chemical reagent is introduced to the infiltration galleries this requirement may be considered.	Operation of Class V.A. wells, including subsurface fluid distribution systems, as defined in R. 61-87.2(Z), for underground injection of any fluids into the subsurface or ground waters of the State of South Carolina – applicable	SCDHEC R.61-87.14(D)
	Shall at all times properly operate and maintain all facilities and systems of treatment and controls which are installed or used.		SCDHEC R.61-87.13(X)
	Shall report malfunction of injection system which may cause fluid migration into or between underground sources of drinking water; shall immediately stop injection upon determination that the injection system has malfunctioned and could cause fluid migration into or between underground sources of drinking water; shall not restart the injection system until the malfunction has been corrected.		SCDHEC R.61-87.13(EE)
Monitoring of underground infiltration galleries	An appropriate number of monitoring wells shall be completed into the injection zone and into any underground sources of drinking water which could be	Monitoring of Class V.A. wells, including a subsurface fluid distribution system, as defined in R. 61-87.2(Z), used for	SCDHEC R.61-87.14(G)(1)

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
	affected by the injection operation. These wells shall be located in such a fashion as to detect any excursion of injection fluids, process by-products, or formation fluids outside the injection area or zone. If the operation may be affected by subsidence or catastrophic collapse the monitoring wells shall be located so that they will not be physically affected.	underground injection of any fluids into the subsurface or ground waters of the State of South Carolina – **applicable**	
	In determining the number, location, construction and frequency of monitoring of the monitoring wells the following criteria shall be considered: (a) The population relying on the USDW affected or potentially affected by the injection operation; (b) The proximity of the injection operation to points of withdrawal of drinking water; (c) The local geology and hydrogeology; (d) The operating pressures and whether a negative pressure gradient is being maintained; (e) The nature and volume of the injected fluid, the formation water, and the process by-products; and (f) The injection well density.		SCDHEC R.61-87.14(G)(2)
	Monitoring requirements shall, at a minimum, specify: • Monitoring of the nature of injected fluids with sufficient frequency to yield representative data on its characteristics; • Monitoring of injection pressure and either flow rate or volume semi-monthly, or metering and daily recording of injected and produced fluid volumes as appropriate • Monitoring of the fluid level in the injection zone semi-monthly, where appropriate and monitoring of the parameters chosen to measure water quality in the monitoring wells semi-monthly. Note: Monitoring of injections and monitoring wells will be conducted pursuant to an EPA-approved monitoring plan documented in appropriate CERCLA RD/RA		SCDHEC R.61-87.14(G)(3)(a),(b),(d)

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
	document.		
Plugging and abandonment of infiltration galleries	The well to be abandoned shall be in a state of static equilibrium with the mud weight equalized top to bottom, by a method prescribed by the Department prior to the placement of the cement plug(s).	Abandonment of Class V.A wells, including subsurface fluid distribution systems, as defined in R. 61-87.2(Z), for underground injection of any fluids into the subsurface or ground waters of the State of South Carolina – **applicable**.	SCDHEC R.87.15(B)
	The well must be plugged in such a manner which will not allow the movement of fluids either into or between underground sources of drinking water.		SCDHEC R.87.15(C)
	Wells must be closed in a manner that complies with prohibition of fluid movement in 40 CFR 144.82(a). Also, any soil, gravel, sludge, liquids, or other materials removed from or adjacent to the well must be disposed or otherwise managed in accordance with substantive applicable Federal, State, and local regulations and requirements.	Class V wells [as defined in 40 CFR 144.6(e)] used to inject reagents – applicable	40 CFR 144.82(b)
Waste Characterization and Storage ***(e.g., excavated soils, soil cuttings from well installation, monitoring well purge water)***			
Characterization of solid waste	Must determine if solid waste is a hazardous waste using the following method: Should first determine if waste is excluded from regulation under 40 CFR 261.4; and	Generation of solid waste as defined in 40 CFR 261.2 – **applicable**	40 CFR 262.11(a) SCDHEC R. 61-79 262.11*(a)*
	Must determine if waste is listed as hazardous waste under 40 CFR Part 261.	Generation of solid waste which is not excluded under 40 CFR 261.4(a) – **applicable**	40 CFR 262.11(b) SCDHEC R. 61-79 262.11*(b)*
	Must determine whether the waste is (characteristic waste) identified in subpart C of 40 CFR Part 261by either: (1) Testing the waste according to the methods set forth in subpart C of 40 CFR part 261, or according to an equivalent method approved by the Administrator	Generation of solid waste which is not excluded under 40 CFR 261.4(a) – **applicable**	40 CFR 262.11(c) SCDHEC R. 61-79 262.11*(c)*

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
	under 40 CFR 260.21; or (2) Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used.		
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste which is determined to be hazardous waste – **applicable**	40 CFR 262.11(d) SCDHEC R. 61-79 262.11*(d)*
Determinations for management of hazardous waste [1]	Must determine each EPA Hazardous Waste Number (waste code) applicable to the waste in order to determine the applicable treatment standards under 40 CFR 268 *et seq.*. *Note:* This determination may be made concurrently with the hazardous waste determination required in Sec. 262.11 of this chapter.	Generation of hazardous waste for storage, treatment or disposal – **applicable**	40 CFR 268.9(a) SCDHEC R. 61-79 268.9*(a)*
	Must determine the underlying hazardous constituents [as defined in 40 CFR 268.2(i)] in the characteristic waste.	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal – **applicable**	40 CFR 268.9(a) SCDHEC R. 61-79 268.9*(a)*
	Must determine if the hazardous waste meets the treatment standards in 40 CFR 268.40, 268.45, or 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste. *Note:* This determination can be made concurrently with the hazardous waste determination required in 40 CFR 262.11.	Generation of hazardous waste for storage, treatment or disposal – **applicable**	40 CFR 268.7(a) SCDHEC R. 61-79 268.7*(a)* (1)

[1] During installation of the underground infiltration galleries, overburden soil will be excavated and then replaced above the infiltration galleries. Soil cuttings will also be generated if additional monitoring wells are required. While it is anticipated that the soil cuttings and overburden soil will be non-hazardous, the soils will be tested and managed in accordance with RCRA waste characterization, storage and disposal requirements, as necessary.

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
Temporary storage of hazardous waste in containers	A generator may accumulate hazardous waste at the facility provided that: • waste is placed in containers that comply with 40 CFR 265.171-173; and • the date upon which accumulation begins is clearly marked and visible for inspection on each container • container is marked with the words "hazardous waste"; or	Accumulation of RCRA hazardous waste on site as defined in 40 CFR 260.10 –**applicable**	40 CFR 262.34(a)(1) and (2) SCDHEC R. 61-79 262.34*(a)* (1) and (2) 40 CFR 264.34(a)(3) SCDHEC R. 61-79 262.34*(a)* (3)
	• container may be marked with other words that identify the contents.	Accumulation of 55 gal. or less of RCRA hazardous waste or 1 quart of acutely hazardous waste listed in 261.33(e) at or near any point of generation – **applicable**	40 CFR 262.34(c)(1) SCDHEC R. 61-79 262.34*(c)* (1)
Use and management of hazardous waste in containers	If container holding waste is not in good condition (e.g. severe rusting, structural defects), or if it begins to leak, must transfer waste into container in good condition.	Storage of RCRA hazardous waste in containers – **applicable**	40 CFR 265.171 SCDHEC R. 61-79 265.171
	Must use a container made or lined with materials which will not react with, and are otherwise compatible with, the hazardous waste to be stored, so that the ability of the container to contain the waste is not impaired.		40 CFR 265.172 SCDHEC R. 61-79 265.172
	A container holding hazardous waste must always be closed during storage, except when necessary to add or remove waste. A container holding hazardous waste must not be opened, handled, or stored in a manner which may rupture the container or cause it to leak.		40 CFR 265.173(a) and (b) SCDHEC R. 61-79 265.173*(a)* and *(b)*
Storage of hazardous waste in container area	Area must have a containment system designed and operated in accordance with 40 CFR 265.175(b).	Storage of RCRA hazardous waste in containers ***with free liquids*** – **applicable**	40 CFR 264.175(a) SCDHEC R. 61-79 264.175*(a)*
	Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or	Storage of RCRA-hazardous waste in containers that ***do not contain free liquids*** (other than F020, F021, F022,	40 CFR 265.175(c)(1) and (2)

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
	Containers must be elevated or otherwise protected from contact with accumulated liquid.	F023, F026 and F027) – **applicable**	SCDHEC R. 61-79 265.175*(c)* (1) and (2)
Closure of RCRA container storage unit	At closure, all hazardous waste and hazardous waste residues must be removed from the containment system. Remaining containers, liners, bases, and soils containing or contaminated with hazardous waste and hazardous waste residues must be decontaminated or removed. [Comment: At closure, as throughout the operating period, unless the owner or operator can demonstrate in accordance with 40 CFR 261.3(d) of this chapter that the solid waste removed from the containment system is not a hazardous waste, the owner or operator becomes a generator of hazardous waste and must manage it in accordance with all applicable requirements of parts 262 through 266 of this chapter].	Storage of RCRA hazardous waste in containers in a unit with a containment system – **applicable**	40 CFR 264.178
Waste treatment and disposal — contaminated soils, monitoring well purge water			
Disposal of solid waste	Shall ultimately dispose of solid waste at facilities and/or sites permitted or registered by the Department for processing or disposal of that waste stream.	Generation of solid waste intended for off-site disposal – **relevant and appropriate**	SCDHEC R. 61-107.5(D)(3)
Disposal of RCRA-hazardous waste in an off-site land-based unit	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR 268.40 before land disposal.	Land disposal, as defined in 40 CFR 268.2, of restricted RCRA waste – **applicable**	40 CFR 268.40(a) SCDHEC R. 61-79 268.40*(a)*

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
	All underlying hazardous constituents [as defined in 40 CFR 268.2(i)] must meet the Universal Treatment Standards, found in 40 CFR 268.48 Table UTS prior to land disposal.	Land disposal of restricted RCRA characteristic wastes (D001-D043) that are not managed in a wastewater treatment system that is regulated under the CWA, that is CWA equivalent, or that is injected into a Class I nonhazardous injection well – **applicable**	40 CFR 268.40(e) SCDHEC R. 61-79 268.40*(e)*
	Must be treated according to the alternative treatment standards in 40 CFR 268.49(c) <u>or</u> Must be treated according to the UTSs [specified in 40 CFR 268.48 Table UTS] applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal.	Land disposal, as defined in 40 CFR 268.2, of restricted hazardous soils – **applicable**	40 CFR 268.49(b) SCDHEC R. 61-79 268.49*(b)*
	To determine whether a hazardous waste identified in this section exceeds the applicable treatment standards of 40 CFR 268.40, the initial generator must test a sample of the waste extract or the entire waste, depending on whether the treatment standards are expressed as concentration in the waste extract or waste, or the generator may use knowledge of the waste. If the waste contains constituents (including UHCs in the characteristic wastes) in excess of the applicable UTS levels in 40 CFR 268.48, the waste is prohibited from land disposal, and all requirements of part 268 are applicable, except as otherwise specified.	Land disposal of RCRA toxicity characteristic wastes (D004-D011) that are newly identified (i.e., wastes or soil identified by the TCLP but not the Extraction Procedure) – **applicable**	40 CFR 268.34(f) SCDHEC R. 61-79 268.34*(f)*

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
	Transportation of Wastes		
Transportation of hazardous waste *on-site*	The generator manifesting requirements of 40 CFR 262.20 through 262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 CFR 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way.	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way – **applicable**	40 CFR 262.20(f) SCDHEC R. 61-79 262.20*(f)*
Transportation of hazardous waste *off-site*	Must comply with the generator requirements of 40 CFR 262.20-23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding, Sect. 262.40, 262.41(a) for record keeping requirements, and Sect. 262.12 to obtain EPA ID number.	Generator who initiates the off-site shipment of RCRA-hazardous waste – **applicable**	40 CFR 262.10(h) SCDHEC R. 61-79 262.10*(h)*
Transportation of hazardous materials	Shall be subject to and must comply with all applicable provisions of the HMTA and DOT HMR at 49 CFR 171-180.	Any person who, under contract with a department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material – **applicable**	49 CFR 171.1(c)
Transportation of samples (i.e. solid waste, soils and wastewaters)	Are not subject to any requirements of 40 CFR Parts 261 through 268 or 270 when: • the sample is being transported to a laboratory for the purpose of testing; or • the sample is being transported back to the sample collector after testing. • the sample is being stored by sample collector before transport to a lab for testing.	Samples of solid waste <u>or</u> a sample of water, soil for purpose of conducting testing to determine its characteristics or composition – **applicable**	40 CFR 261.4(d)(1)(i)-(iii) SCDHEC R. 61-79 261.4*(d)* (1)

Table 25 - Action-Specific ARARs/TBCs, Former IMC Fertilizer Site			
Action	**Requirements**	**Prerequisite**	**Citation**
	In order to qualify for the exemption in 40 CFR 261.4 (d)(1)(i) and (ii), a sample collector shipping samples to a laboratory must: • Comply with U.S. DOT, U.S. Postal Service, or any other applicable shipping requirements. • Assure that the information provided in (1) thru (5) of this section accompanies the sample. • Package the sample so that it does not leak, spill, or vaporize from its packaging.		40 CFR 261.4(d)(2) 40 CFR 261.4(d)(2) (ii)(A) and (B) SCDHEC R. 61-79 261.4*(d)* (2)(ii)(A) and (B)
Monitoring Well Installation, Operation, and Abandonment			
Underground Infiltration Galleries - Installation, Operation, and Abandonment			
Waste Characterization and Storage ***(e.g., excavated soils, soil cuttings from well installation, monitoring well purge water)***			
Waste treatment and disposal — contaminated soils, monitoring well purge water			
Transportation of Wastes			

ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
CWA = Clean Water Act of 1972
DEACT = deactivation
DOT = U.S. Department of Transportation
EPA = U.S. Environmental Protection Agency
HMR = Hazardous Materials Regulations
HMTA = Hazardous Materials Transportation Act
LDR = Land Disposal Restrictions

NPDES = National Pollutant Discharge Elimination System
RCRA = Resource Conservation and Recovery Act of 1976
SCDHEC = South Carolina Department of Health and Environmental Control
TBC = to be considered
TCLP = Toxicity Characteristic Leaching Procedure
UHC = underlying hazardous constituents
UTS = Universal Treatment Standard
WWTU = Waste Water Treatment Unit

Table 26 - LOCATION SPECIFIC ARARs and TBC – Former IMC Fertilizer Site			
Location Characteristics	**Requirements**	**Prerequisite**	**Citation**
Floodplains and Wetlands (associated with Fairforest Creek)			
Location encompassing aquatic ecosystem as defined in 40 *CFR* 230.3(c)	Except as provided under CWA §404(b)(2), no discharge of dredged or fill material is permitted if there is a practicable alternative that would have less adverse impact on the aquatic ecosystem or if it will cause or contribute to significant degradation of the waters of the United States.	Actions that involves the discharge of dredged or fill material into *waters of the United States* including jurisdictional wetlands – **relevant and appropriate**	40 *CFR* 230.10(a) and (c)
	Except as provided under CWA §404(b)(2), no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem. 40 CFR 230.70 et seq. identifies such possible steps.		40 CFR 230.10(d)
Nationwide Permit Program	Must comply with the substantive requirements of the NWP 38, General Conditions, as appropriate.	Discharge of dredged or fill material into *waters of the United States*, including jurisdictional wetlands – **relevant and appropriate**	Nationwide Permit (38) – Cleanup of Hazardous and Toxic Waste 33 *CFR* 323.3(b)
Presence of wetlands	Requires Federal agencies to evaluate action to minimize the destruction, loss or degradation of wetlands and to preserve and enhance beneficial values of wetlands.	Actions that involve potential impacts to, or take place within, wetlands – **TBC**	Executive Order 11990 – *Protection of Wetlands* - Section 1.(a)
Presence of floodplains	Shall consider alternatives to avoid, to the extent possible adverse effects and incompatible development in the floodplain.	Federal actions that involve potential impacts to, or take place within, floodplains –**TBC**	Executive Order 11988 – *Floodplain Management* -Section 2.(a)(2)

ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
EPA = U.S. Environmental Protection Agency
SCDHEC = South Carolina Department of Health and Environmental Control
CWA = Clean Water Act
TBC = to be considered

streams). The Location-Specific ARARs/TBC guidance for the selected remedial alternative are listed in **Table 26**. The Location-specific ARARs for the Site are associated with protection of Fairforest Creek, the floodplain of Fairforest Creek, and the wetlands around Fairforest Creek. These requirements include Clean Water Act ARARs prohibiting the discharge of dredge or fill material into waters of the United States including jurisdictional wetlands that will adversely impact aquatic ecosystems (40 CFR 230.10), general conditions in the Nationwide Permit (38) Cleanup of Hazardous and Toxic Waste that are relevant and appropriate to jurisdictional wetlands (33 CFR 323.3(b)), and Executive Orders 11990 and 11988 "to-be-considered" in actions involving potential impacts to, or taking place within, wetlands or floodplains, respectively.

Requirements Applicable to Off-Site Activities
Any remediation wastes that are generated (e.g., excavated soils, soils cuttings from well boring, or monitoring well purge water) and subsequently transferred off-site or transported in commerce along public right-of-ways must meet any applicable requirements (including administrative portions) such as those for packaging, labeling, marking, manifesting, and placarding requirements for hazardous materials (40 CFR 262.10(h), SCDHEC R. 61-79 262.10(h); 49 CFR 171.1(c)). In addition, CERCLA Section 121(d)(3) provides that the off-site transfer of any hazardous substance, pollutant, or contaminant generated during CERCLA response actions be sent to a treatment, storage, or disposal facility that is in compliance with applicable federal and state laws and has been approved by EPA for acceptance of CERCLA waste. See also 40 C.F.R. § 300.440 (so called "Off-Site Rule").

13.3 Cost Effectiveness

The selected remedy is cost effective because the remedy's costs are proportional to its overall effectiveness. This determination was made by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (i.e. that are protective of human health and the environment and comply with all Federal and any more stringent State ARARs). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short term effectiveness). The overall effectiveness of each alternative was then compared to each alternative's costs to determine cost-effectiveness. The relationship of the overall effectiveness of this alternative was determined to be proportional to its costs and hence represents a reasonable value for the money to be expended. The present worth cost of the selected remedy was comparable to the other in-situ technologies but was chosen because of its proven abilities and its expected long term effectiveness.

13.4 Utilization of Permanent Solutions to the Maximum Extent Practicable

EPA has determined that the Selected Remedy represents the maximum extent to which permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable can be utilized at the Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the Selected Remedy provides the best balance in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element, and considering State and community acceptance. The Selected Remedy treats the contaminants in groundwater. It satisfies the criteria for long-term effectiveness by removing the contaminants from the groundwater. The Selected Remedy does not present short-term risks different from the other treatment alternatives. There are no special implementability issues that set the Selected Remedy apart from any of the other alternatives evaluated.

13.5 Preference for Treatment as a Principal Element

EPA has determined that the in-situ treatment of the low pH soil and the groundwater will meet the statutory preference for the selection of a remedy that involves treatment as a principal element.

13.6 Five-Year Review Requirement

According to the NCP, 40 C.F.R.§300.430(f)(4)(ii), if a remedial action is selected that results in hazardous substances, pollutants or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

Until groundwater contaminants are below cleanup levels and the Site is available for unlimited use and unrestricted exposure, EPA will perform five year reviews to ensure the protectiveness of human health and the environment. A policy review will be conducted within five years after the completion of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

14.0 RESPONSIVENESS SUMMARY

The proposed plan was issued in June 2014. The public comment period began on June 9, 2014 and ended on July 9, 2014. EPA received no comments on the proposed plan during the comment period. The public meeting for the proposed plan was held on June 26, 2014 at a neighborhood community center. Representatives of EPA, SC

DHEC and the PRP group were in attendance. The State Representative that represents the area attended, as well as approx. 25 local residents. The transcript of the meeting is provided in Appendix C.

APPENDIX A
SC DHEC CONCURRENCE LETTER

D H E C
PROMOTE PROTECT PROSPER
Catherine B. Templeton, Director
Promoting and protecting the health of the public and the environment

August 21, 2014

Randall Chaffins, Acting Director
Superfund Division
US EPA, Region IV
Atlanta Federal Center
61 Forsyth Street, SW
Atlanta, Georgia 30303

Re: International Mineral and Chemical Corporation (IMC) Fertilizer Superfund Site Record of Decision

Dear Randall:

The Department has reviewed and concurs with all parts of the Record of Decision (ROD) dated August 2014 for the International Mineral and Chemical Corporation (IMC) Fertilizer Superfund Site located in Spartanburg County, South Carolina. In concurring with this ROD, the South Carolina Department of Health and Environmental Control (SCDHEC) agrees that the Selected Remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), 42 United States Code (USC) §9601 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300, as amended. The Selected Remedy is Alternative 2 – Infiltration Galleries. The response action selected in this ROD is necessary to protect the public health and the environment from actual or threatened releases of hazardous substances.

Alternative 2, the selected remedial alternative for the IMC Site, will address the contaminated groundwater and the low pH soil at the Site. It provides for in-situ treatment of the soil and groundwater that contains contaminants above the cleanup levels. Institutional Controls will be implemented at the IMC Site to limit use to commercial, industrial, and/or recreational purposes. Institutional Controls will also be implemented to specifically restrict future withdrawal of groundwater from the IMC Site.

The Selected Remedy for the IMC Site is estimated to cost $2,190,000 for the entire site. It is expected to take 15 years to achieve the remedial action objectives. The major components of this alternative are:

- Infiltration galleries in and downgradient of the former sulfuric acid area
- Periodic application of a neutralizing solution
- Mandatory five-year reviews over the course of a 30-year period
- Institutional controls such as deed notices and limitations on land use and site-wide groundwater use restrictions

SCDHEC agrees that the Selected Remedy presented in the ROD is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, are cost-effective, and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable.

If you should have any questions regarding the Department's concurrence with the ROD, please contact Greg Cassidy at (803) 898-0910.

Sincerely,

Daphne G. Neel

Daphne G. Neel, Bureau Chief
Division of Land and Waste Management

CC: Don Siron, BLWM
Ken Taylor, BLWM
Susan Fulmer, BLWM
Greg Cassidy, BLWM
Kayse Jarman, BLWM
Giezelle Bennett, EPA
EQC Upstate
50879, file

APPENDIX B
PUBLIC MEETING TRANSCRIPT

IMC SITE
SPARTANBURG, SOUTH CAROLINA
PROPOSED PLAN
PUBLIC MEETING
JUNE 26, 2014
6:33 P.M.

ORIGINAL

LOCATION
C.C. Woodson Community Center
210 Bomar Avenue
Spartanburg, South Carolina 30906

APPEARANCES

HONORABLE HAROLD MITCHELL
District 31 Representative

COUNCILMAN ROBERT REEDER

GIEZELLE BENNETT
Remedial Project Manager

L'TONYA SPENCER
Community Involvement Coordinator

DAN MADISON
Mosaic Consultant

GREG CASSIDY
South Carolina DHEC

KAYSE JARMAN
South Carolina DHEC

Page 2

MS. SPENCER: Good evening. We are going to go ahead and get started. Hopefully, if more people come in they will join the conversation as we go.

My name is L'Tonya Spencer. I am with the Environmental Protection Agency, and I am your Community Involvement Coordinator for the IMC Site. And we are here tonight to talk to you about what we are proposing to complete the cleanup of the site. Giezelle Bennett is the Remedial Project Manager, she will be presenting.

Introduce yourselves.

MR. CASSIDY: I'm Greg Cassidy with South Carolina DHEC.

MS. JARMAN: I'm Kayse Jarman with South Carolina DHEC also.

REPRESENTATIVE MITCHELL: Harold Mitchell.

MS. SPENCER: Honorable Harold Mitchell.

What we are going to do is go ahead and get started. Giezelle is going to do her presentation. You have copies of her presentation to follow along with her. And after she finishes her presentation we will have a question-and-answer session. Because we are having the meeting transcribed, if you have any questions, if you will state your name first and then ask your question or

Page 3

make your statement so that we will have a record of it for the record of decision for the Executive Summary, because this will be part of taking your comments for the thirty-day comment period.

Giezelle.

MS. BENNETT: Good evening everyone, and welcome to the meeting. Today we are going to talk about the proposed plan for the IMC Site, the International Mineral and Chemical site.

Just a brief background, the site was a fertilizer production facility. It operated from 1910 to 1986. And the fertilizer consisted of nitrogen phosphorus and potassium. And they also used sulphuric acid in the process.

The property is forty acres in size and is located right here in the Arkwright Community. The site is considered industrial, but, as you know, quite a few people live near the site.

This is a picture of how the site looked right after the facility was closed. And the next picture shows the site as it looks today. All the buildings have been removed. The only things there are concrete foundations and foliage, and it's partially fenced.

And this is an aerial view of the site.

Page 4

It shows the IMC Site and also industries surrounding it, Arkwright, Rhodia, Mount Vernon Mills. You all are probably very familiar with the area.

Okay. The site activity. In July 2001, the EPA signed an agreement with the owner of the property to investigate the contamination at the site. And the first thing that was done was a removal. It was done to remove residual contamination that was found at the site. That was in 2002, they removed 15,000 tons of contaminated soil and debris.

In 2004 to 2006 we did what we call a remedial investigation, where we investigated and found out where all the contamination was on the property.

In 2008 we did a feasibility study where we looked at various alternatives to cleaning up that contamination.

During that remedial investigation we found that additional process residuals were below the water table, thus they were continuing to negatively impact the groundwater. And when I say "process residuals," I mean production waste from actual fertilizer production. And this is a picture

Page 5

of it. And trusty Dan there has a picture showing what it is.

This slide shows how the contamination was in 2008. The blue part is all the groundwater contamination that we had that was above the drinking water standards. The pink are still additional process residuals that were left. And the brown is surface soil that was also still contaminated.

At that time the decision was made to do a non-time critical removal action. And why did we do that? Well, it allowed the known sources of contamination to be addressed quickly. And we were also going to monitor, to determine if it had a positive impact on the groundwater.

The non-time critical removal action was conducted in 2010 to 2011, and it addressed those areas that were on the previous slide, the surface soil. We also had an empty explosives bunker and the rest of process residuals. So another 21,000 cubic yards of material were removed. But more important than that, they put down 2,875 tons of limestone in the bottom of the excavations, and that was to help pH adjustment. And I will talk about that a little bit later.

Page 6

So this slide shows the monitoring results that were conducted. As I told you, the non-time critical removal action was done in 2010, 2011, and as you can see on this table the contamination in the groundwater dramatically dropped. Some things were 100 percent. But this was just in three years that the impact from that removal was felt on the groundwater. But as dramatic as that was, we still have some contamination in what we call the northeast area that's a concern. And this slide shows groundwater with a very low pH level.

And this next table shows what that slide, that previous slide showed, that as you saw from the other area, the numbers dramatically dropped. In this area, they didn't dramatically drop. In some instances, you can see they went up. So this is the area that we need to address now (indicating).

So looking at trying to find a reason why the groundwater had a low pH, an investigation was done in the old sulphuric acid plant area. And the soil doesn't contain contaminants above the cleanup goals. But the areas you see in yellow, the soil has a pH of less than three and a half.

And I don't know if you're familiar with the pH scale, but 1 is acidic and 12 is a base. So

Page 7

this soil is near acid range. And you can say, well, what's the big deal about low pH?

Well, rain falls through that soil that has the low pH. And, you know, everybody has heard of acid rain. Well, in essence, the rain goes through the low pH soil and then that, in turn, mobilizes the naturally occurring metals in the soil. So the rain goes through the soil, the low pH soil, turns to acid rain. And then that leaches out all of the metals that are naturally occurring in the soil, so then you have groundwater contamination. So it's not coming from the fertilizer production, per se, but the area that they used is causing the contamination. And this low pH soil, it starts at ten feet below ground surface. And the depth of water in this area is twenty-two to twenty-four feet. And the groundwater flows towards Fairforest Creek.

So now what do we hope to achieve in this cleanup? Well, we want to prevent human exposure to the groundwater contamination. We want to minimize any migration of the contaminants from the groundwater to the surface water at Fairforest Creek, and we want to restore the groundwater to beneficial use. So we have remediation goals.

Page 8

These are what we call federal and state maximum contaminant levels, or drinking water standards.

Now, I want to be clear that nobody is drinking the water there. This whole area is on city water. And we will put deed restrictions so nobody will ever be able to drink the drinking water. But it's a federal and state law that if you contaminate groundwater, then you're supposed to restore it. So that's our objective.

And as you can see, fluoride and nitrate are the two things that are most prevalent in the groundwater. And I have a handout that you all probably picked up at the beginning that says a little bit about fluoride and nitrate in water.

So four alternatives were developed to address the contamination that we found. The first was no action. That's do nothing. And we always have to consider that as a baseline, something to compare the results of the other ones to.

We also have infiltration galleries with institutional controls, phytoremediation with institutional controls, and excavation and treatment outside of the excavation site, and then on-site disposal with institutional controls.

Now, this is just a proposal, the

Page 9

Infiltration Galleries. And it will be further developed in a remedial design. But basically, what we are looking is a series of eight to ten-foot deep trenches. And each trench will have a two-foot diameter perforated pipe. And those pipes will be filled with neutralizing solution like sodium carbonate, so something to address the acid. You know, you give it a base and it meets somewhere in the middle, hopefully.

And institutional controls, when we are talking about institutional controls, we are talking about deed restrictions and beefing up the physical restrictions like fully fencing the site. It's only partially fenced now. But anyway, that would propose a cost of two million sixty thousand dollars.

The next alternative is phytoremediation. And I don't know if you have heard of this or not, but trees actually help with the cleanup. So they would put approximately 150 trees in three rows. And we would use something called TreeWell technology. And I don't know if you have ever seen roots, sometimes roots grow out on the surface of the soil. Well, this kind of technology would make them grow downward so they could absorb the contaminated groundwater and it cleans it up.

We would also have institutional controls on that as well, and that price would be 2.29 million.

The fourth alternative is we would strictly just address the low pH soil only. We would excavate everything in that red shape there, and we would treat it with a neutralizing agent. Dig it up, treat it, and then put it back down in the same hole. And that price would be 5.1 million dollars.

So the next table is the Summary. The No Action, of course, is no dollars. The Infiltration Galleries are 2.06 million. Phytoremediation came in at 2.29 million, and the Excavation and putting it back in the hole would be 5.1 million dollars.

Our next step was we do a comparative analysis. We have nine criteria that we have to use to compare the different alternatives. And whatever alternative that we choose must meet the first two. It must be protective of human health and environment, and it must comply with all federal and state laws. After then we would look at long-term and short-term effectiveness, if it reduces the toxicity mobility and volume of the contamination,

is it easily implemented and, of course, the cost.

And the last two are State Acceptance from South Carolina DHEC, in this case, and the community acceptance, which is why we asked for comments.

So based upon the comparative analysis and looking at the various alternatives, the one that the EPA is recommending and DHEC is recommending is Alternative 2. Why? Because it addresses both the low pH soil and the resulting contaminated groundwater. It's safe, effective, it's easily implemented, and it's cost effective.

And that's the end of my presentation.

MS. SPENCER: So at this point we are going to have the questions and answers. And we do have a transcriptionist, so again, if you have questions or you want to make a statement or a comment, please state your name first and then give your question or your comment.

I know some people came in late, so if you have had an opportunity to look through the presentation and you have questions or you want her to go back and explain something you didn't quite understand, no question is a dumb question, so please ask.

Any questions?

MS. SIMS: Elaine Sims. What all they proposing on here, to build something on these sites that already been cleaned up? Or did I come in late and I don't know -- I was kind of late coming in, so I don't know exactly where you was talking about.

MS. BENNETT: This is at the IMC Site.

MS. SIMS: What do they planning on doing with it? Is someone planning on doing something with it at the site?

MS. BENNETT: You mean after we finish the cleanup?

MS. SIMS: Has it not been cleaned up?

MS. BENNETT: All the soil has been cleaned up, but now the groundwater needs to be cleaned up.

MS. SIMS: Okay. So they are coming back in here to do the -- someone is coming back in to do the groundwater of it?

MS. BENNETT: Right. Right.

MS. SIMS: So where is the water? Who is it affecting, someone who using well water or something like that?

MS. BENNETT: No. That's the thing. It's not affecting anybody. The groundwater from this site flows and goes into Fairforest Creek. And once it gets there, it mixes with the water that's already

there. So am I answering your question?

MS. SIMS: Uh-huh. Is it almost similar to what they are taking on over in Anderson with their water? You know, they having a problem with their water right now.

MS. BENNETT: I don't know anything about that.

MS. SIMS: It has been on the news, they are having problems with their water.

So this water is just going into Fairforest Creek --

MS. BENNETT: Right.

MS. SIMS: -- and mixing in with the regular water?

MS. BENNETT: It's mixing in with the surface water, so this doesn't affect your drinking water at all.

MS. SIMS: Would it not?

MS. BENNETT: No, it doesn't. If you were living right there, on the property, and you had a drinking water well, then I would say yes, it affects you. But if you don't live there and you're not drinking water right from that site, then no, it doesn't affect South Spartanburg's drinking water.

MS. SIMS: So when they clear up this water, then what are they going to do with the site? What

Page 14

they going to do with the site, just clear it up?
MS. BENNETT: Well, the EPA's vision is to clean it up, restore soil and groundwater, so what we consider unlimited use; that somebody can come in and develop it or put whatever they want to on the site without it being contaminated; without it harming anybody.
MS. SIMS: You saying "whatever." Now, it can't be no whatever they want to put in there. Because if you cleaning up the water now for contamination, we don't want somebody to come in there and build something that's going to contaminate it again.
MS. BENNETT: No. Well, it will have deed restrictions on it. There will be certain things that you can and cannot do. And I think Mr. Mitchell, the Honorable Harold Mitchell can address that about long-term --
MS. SIMS: Is this the only site they talking about, the IMC site?
MS. BENNETT: That's the only one we are talking about. Right.
MS. SPENCER: Any other questions, comments?
MS. BENNETT: Do you want to take it from here?
MS. SPENCER: Mr. Mitchell.

Page 15

MS. SIMS: So the people that living in Fairforest will come here, you know? So the people living in Fairforest Creek, down that way, their water is not being contaminated?
MS. SPENCER: They are on city water.
MS. SIMS: So where is this water going?
MS. BENNETT: Right here, in Fairforest Creek.
MS. REEDER: Fairforest Creek doesn't run off into a supply, a water supply, I don't think so.
MS. SIMS: That's what I'm saying, where is the water going? I mean, you know, where does Fairforest Creek go? Where does it go?
MS. REEDER: It's just a natural resource. It doesn't supply any resource for human consumption.
MS. SIMS: But where is it going? It's just going out, just making its way anywhere? Where does it end up at?
MS. REEDER: It's a mainstream throughout the city.
MS. SIMS: Do you know where it goes?
MS. REEDER: It's a mainstream throughout the city, but it doesn't supply -- it's not a runoff in any kind of physical resource.
MR. CASSIDY: Greg Cassidy with South Carolina DHEC. The water is the groundwater. Underneath all

Page 16

the ground there is what's called aquifers of water. And so this is a layer of water that sits mainly in that area that was listed on that map. And I don't know if you can get to that one that has the shaded area there, but as it goes towards Fairforest Creek there is actually less and less impact on that groundwater as it goes. Now, there is a little bit that go goes into the creek, but the flow of the creek is so much that you don't even detect it in the creek.
MS. SIMS: So why didn't they get this far when they was cleaning up the site? If they had known it was contaminated, why they didn't do it all at once? Why they got to come back now if they never did get it --
MS. SPENCER: The first part was for the soil. Now they are coming back for the water.
MS. SHACKLEFORD: So it's done in stages.
MS. SPENCER: Yes.
MS. SIMS: Okay.
REPRESENTATIVE MITCHELL: If you can go back to where she was asking on an earlier part, in 2001 when you showed the 15,000 tons of soil that was removed, it shows on there, during the stages, what was removed up to this point right now. And what is

Page 17

still impacted is what they are addressing on the ground. It's on page six, there was a Consent Order back in 2002 where a lot of this started with the removals and then addressing those ponds. And over time the more -- I guess over that time, going back up to 2011, '10, '11, and it's still seeing with the monitoring that it's still impacting. So what they are looking at now is how do you actually address that groundwater and deal with the pH, the problems with the pH that's on -- I forgot the table that you had it on.
MS. BENNETT: We consider this to be the last phase of it. We have done two removals of soil. And now this action will address the groundwater, and then that should totally clean up the site.
MS. SIMS: So they will have to go through all of Fairforest Creek, whatever area that this water is at, and clean that up too?
MS. BENNETT: No.
MS. SIMS: It's just on that site that they going to clean up?
MS. BENNETT: Right.
MS. SIMS: So what happens to the water that's gone through Fairforest Creek then, it's still going to be contaminated?

MS. BENNETT: This groundwater is not contaminating Fairforest Creek. It flows to it. But if you can imagine a big bathtub full of water, if you drop one drop in it, then it's not going to look blue just because you drop a blue drop in it, because it's going to dissipate. And that's what happens with this.

MS. SIMS: As it flows through to Fairforest Creek, it gets less and less contaminated?

MS. BENNETT: Right.

MS. SIMS: But it wasn't contaminated.

REPRESENTATIVE MITCHELL: And I think, too, she came in on the part where you didn't -- not talking about what is the contamination that you're talking about, as far as --

MS. SIMS: Okay. Maybe I missed that part, then. I don't mean to set you back.

MS. BENNETT: That's all right.

REPRESENTATIVE MITCHELL: Ms. Giezelle, you have two charts in here where you're showing how that process of groundwater monitoring results over the pre and post --

MS. BENNETT: This one (indicating)?

REPRESENTATIVE MITCHELL: -- how the percentages decrease?

MS. BENNETT: Yes.

REPRESENTATIVE MITCHELL: Like your lead that was 180 is down to 4.8, and then the percent increased about 97 percent?

MS. BENNETT: Right. That was the impact of that removal.

MS. SIMS: So do the rain have an affect on that water on that site?

MS. BENNETT: Well, it does, in that it infiltrates that low pH soil that I was telling you about. And that, in turn, makes the metals in the soil get into the groundwater, because that soil has low pH. So if we raise the pH of that soil and raise the pH of the groundwater, then we won't have to worry about the metals in the groundwater any more.

MR. CASSIDY: In reality here, when we talk about pH we are not talking about like the soil actually being contaminated. It's really that the soil has a low pH, which makes it more acid. And when water comes through, it becomes acid water and that causes the metals that are already in that soil to move and become mobile and they go into the groundwater. And so if we can raise the pH up of that soil layer there, those metals will stay in

that soil and won't move and go into the groundwater. So it's kind of a difficult thing to think about.

MS. SIMS: So they would have had to take all the contaminated soil from that site in order for it not to go into the groundwater that you're talking about for the iron and all that stuff? Suppose it's still raining, you know, the rain, so that site was already contaminated.

MS. BENNETT: It's just the areas that had a low pH soil that we have to worry about. The whole site doesn't have low pH soil, just that one last area.

MR. CASSIDY: Most of the like contaminants that we are seeing were stuff that you would see in most soil.

MS. SIMS: Like I go dig up my yard right now, I can find the pH there?

MR. CASSIDY: Not pH, per se, but the metals are there. But if you had that low pH and rain came through, they would go through in your yard, as well. So there are metals that are perfectly fine if they are not in your groundwater and not moving.

MS. REEDER: Is this a one-time permanent fix or will there have to be ongoing monitoring and you

may have to come in and do an investigation in the future?

MS. BENNETT: Well, they are proposing to do eight episodes, you know, of infiltrations, putting in a liquid and letting it infiltrate, and then after that we will monitor it. The same as we did after the removals that we did, we will be monitoring the groundwater to see what kind of impact it's having, whether it's positive. So no, we won't just do it and leave. We will do it and monitor, make sure it's working.

MR. DAWKINS: Sidney Dawkins. Who is the determining factor of what process they are going to try to use to make the cleanup? You know, you had the three proposals.

MS. BENNETT: Right.

MR. DAWKINS: Who is going to make that decision? Are y'all going to have the community have a say so in that?

MS. BENNETT: Well, as you saw, one of the criteria was community acceptance. So what we do is, we propose one of the things and we tell you why we think it's the best. And we solicit your comments. And you can say, "No. I think you ought to plant trees" or "No, I think you ought to dig it

Page 22

up." And we have to consider all of that during the commenting period.

MR. DAWKINS: And where are the funds going to come from for which process they are going to choose to do?

MS. BENNETT: Well, this is what we call a PRP lead. The site owner is paying for it.

MR. DAWKINS: Okay.

MS. REEDER: Is there any monitoring going on with the adjacent sites, with like the Mount Vernon Mills or the Rhodia site?

MS. BENNETT: Those aren't Superfund sites.

MR. CASSIDY: At the Arkwright facility we have ongoing monitoring, plus we have -- we have had monitoring going on at the IMC site from a previous work, but I'm not sure about Mount Vernon.

MS. SIMS: Where is that?

REPRESENTATIVE MITCHELL: Mount Vernon, the one that's above the tract of land. Mount Vernon, right above the railroad tracks in the textile mill.

MS. SIMS: Okay. Okay. I hear you. So they tearing that down too?

REPRESENTATIVE MITCHELL: No. I'm just saying --

MS. REEDER: I was just asking whether someone

Page 23

was monitoring.

REPRESENTATIVE MITCHELL: And then the textile mill, the Arkwright Textile Mill monitors there, as well. There is some up above, right there on Fairforest Creek as well, and those were done in 2007.

MS. REEDER: Is this internal or do they have an external procedure?

REPRESENTATIVE MITCHELL: Ma'am?

MS. REEDER: Is this something that the company, itself, handles, or do they have a certified agency to come in?

REPRESENTATIVE MITCHELL: This one has a voluntary cleanup agreement with the textile mill right now along here (indicating). That was done under DHEC order there, a voluntary cleanup agreement. So there are two wells that are there, because that was something I think we had fifteen years looking at monitoring on that one. And then you have got the monitoring wells that are at the Arkwright dump, and then those wells that have been in place at the fertilizer plant since '86, 1986.

MS. SPENCER: Any other questions?

MS. REEDER: I do. This property has nothing --

Page 24

MS. SPENCER: Can you state your name for us?

MS. REEDER: I'm sorry. May name is Willa Reeder. W-I-L-L-A, last name is Reeder, R-E-E-D-E-R.

The neighborhood I live in is adjacent to the fertilizer plant. To what extent has the contamination from the fertilizer soil, water runoff, et cetera, filtrated to some degree within the mile radius in which we live?

And the reason I ask that is because in my yard we had an amazing sinkhole. Just walking through, and boom, my son's leg, it went all the way down to his knee. And it has created major concerns, having to dig up this and do that and do all kinds of things that was related to the deterioration of the piping that is underground that carries our water. And when I'm sitting and listening to this, knowing that any type of mineral that creates an acid base in soil, you know, over a period of time could something be building up far beyond just the fertilizer site?

MS. BENNETT: Not that we know of. When we -- when I say "we," the company did those two removals, so you know -- I don't have the picture now, but they took over -- I'd say over 300 samples all over

Page 25

this facility, you know, to try to hone in on where the contamination actually was. And so they had a pretty good idea of the outline of how far it went out.

MR. CASSIDY: Most everything, I think, on the site would lead toward Fairforest Creek from the site. So almost nothing goes back toward --

MS. REEDER: So Fairforest would be like a buffer for the contamination entering into Fairforest --

MS. BENNETT: So you live on the other side?

MS. REEDER: Yes. Fairforest Creek, we are on the other side. I don't think that's Fairforest going over on the other side.

REPRESENTATIVE MITCHELL: No. It's a tributary coming from Duncan Park. That's coming from the lake at Duncan Park.

MS. REEDER: I mean, I'm sitting here thinking, and I just know that this happened, and I don't know what it is they are going to do.

MS. BENNETT: And they also put a monitoring well on the other side of Fairforest Creek.

REPRESENTATIVE MITCHELL: You're talking about that, this one right here, Ms. Reeder? That's that tributary you're talking about right there, that comes from up here, right here. And the lake at Duncan Park, that's where that one flows, right there. And your house is right here, on Lincoln (indicating). But it's flowing down from here. And where that pond, here, it was flowing in right here, coming into Fairforest Creek here, that little -- I think there is a trench that was cut way back, I think -- looking at it, back in 1989 when they were looking at that when it was flowing into Fairforest Creek, those ponds into Fairforest Creek at that point there (indicating).

MS. REEDER: Did they use any fertilizer to try to grow the grass back? I mean, this is something our water system is dealing with. And I'm sitting here thinking about all of the above, and I'm going, "For what?" Okay. It was just a question.

MS. BENNETT: You know, the city water, they have all kinds of things they have to go through, qualifications and regulations and everything. So the water that they delivering has to meet all of those limits.

MS. REEDER: I was just concerned because had that been a small child, that whole body would have submerged into the ground. My son is about six-two, and it went up to his knee.

MS. BENNETT: I have heard of sinkholes swallowing whole houses. It's something to think about, I guess.

MS. SPENCER: Any other questions, comments? Anything need to be clarified? Anything not understood?

MS. REEDER: I understand that you're suggesting alternative number 2. What action -- who will you receive this action from? Who will confirm that this is what the community will support?

MS. BENNETT: What we do is, we are soliciting comments now. So if you have a comment either for or against, you could let us know. And after the end of that thirty-day comment period, we consider both what the community has to say, what the state has to say, and we come up with a final decision. And that will be embodied in what we call a Record Of Decision, or ROD, and L'Tonya will notify everybody of that.

MS. SPENCER: And, actually, your comments tonight are being taken on record. That's why we were asking everybody to state your name.

MS. REEDER: Could you clarify, again, for the institutional controls that you have scripted under alternative two, Infiltration Galleries.

Institutional controls, exactly what does that entail?

MS. BENNETT: That would entail deed restriction, deed notifications. It will put limits on what people can do on the site. It will specify that no groundwater wells can be put on the site, those kind of things. And those will be recorded on the deed for that property.

REPRESENTATIVE MITCHELL: There is a deed restriction right now on the Arkwright landfill and the textile mill and the North Street dump right now, as far as those restrictions that are there.

MS. BENNETT: So it will also be on this site, as well.

MS. SPENCER: Yes, sir. Could you state your name, please.

REPRESENTATIVE MITCHELL: Harold Mitchell. I wanted to ask you just one last clarification, even for those that came in, looking at the two alternatives, it looks like even at alternative 4, if you excavate everything off, compared to number 2, digging those -- well, go back to number 4. If you dig everything off, it's kind of like what you did in 2002, you have a huge excavation and you still saw problems.

But alternative 2 looks like where your eight to ten foot trenches, filling it with a neutralizing solution, sodium carbonate, it looks like with the 2 -- I mean, could you explain it? It looks like you're adding something in to help raise the pH, compared to number 4, just moving soil out of there. Am I correct in that?

MS. BENNETT: Right. Alternative 2 addresses both the low pH soil and the low pH groundwater. So as you can see, on alternative 2 you have a series of trenches throughout that plume that we have.

Now, alternative 4 will address just the soil.

REPRESENTATIVE MITCHELL: And so if we get fixated on looking at the price, saying that that may be the better fix because it's five million, in reality, in looking at that, it's not addressing the solution, like you're saying, with that pH. This is just removing soil. As we saw in 2002, removing the soil, you still had problems with, you know, your pH and other things that we thought would be addressed by just removal.

MS. BENNETT: Right. Well, in reality, you know, if you remove all of that low pH soil, eventually the groundwater would clean up. But it

would take a lot longer than alternative 2 would.
REPRESENTATIVE MITCHELL: And that's what I'm saying. I mean, I think alternative 2 looks like if you remove and do what you're proposing to, that could help --
MS. BENNETT: It will be a lot faster.
REPRESENTATIVE MITCHELL: Faster to get the pH to where it needs to be.
MS. BENNETT: Yeah. I didn't go through the times that they are estimating, but alternative 4, I think, is estimated at thirty years, whereas alternative 2 is estimated at fifteen. So, I mean, you cut it in half.
MS. SIMS: These are the three alternatives that they are thinking of doing to the site?
MS. BENNETT: Right.
MS. SIMS: And the costs?
MS. BENNETT: Right. I think there is a chart in there, toward the end, that summarizes how much it costs. And the owner of the property is Mosaic, Vigindustries, and they have been paying for the investigations and the removals, thus far.
Well, we will be here if y'all want to come up and talk to us and ask us something individually.

MS. SPENCER: Mr. Mitchell.
REPRESENTATIVE MITCHELL: Harold Mitchell. Page four, is that the area where we are talking about here on this, page four, this diagram, that area?
MS. BENNETT: That's just a general picture of the site.
MS. SPENCER: It's not the exact location?
MS. BENNETT: No, it's not the exact location of where the sulphuric acid plant is.
REPRESENTATIVE MITCHELL: Because just for clarification for the people here, that's at the back part of the plant back here, at the site back here (indicating)?
MS. SIMS: I was fixing to ask what part of the site is they trying to clear up? It's on the back end of it?
REPRESENTATIVE MITCHELL: It's back down there. Right here, it's back here (indicating).
MS. SIMS: I asked where the location was. And since it's in the back area of it, the place that's going to be cleaned up, since they did the whole area, they just got that little piece of area that they need to work on or try to clean up?
REPRESENTATIVE MITCHELL: Just clarification

now, through the years, as far as taking down the facility, what happened, it was deconstructed in 2002 -- 2000? Well, 2000, when it was deconstructed, they went back to this point, 2001, that was the 15,000 tons that were removed. And over that course of time they continued, and that's where -- right there, where they are at, is this last piece that needs to be addressed.
MS. SIMS: What they going to do about the Mount Vernon Mill thing, then?
REPRESENTATIVE MITCHELL: It's closed.
MS. SIMS: It's closed down too, ain't it?
REPRESENTATIVE MITCHELL: Yes. They just went out of business, like all the other textile mills. And they have been trying to sell it for the last --
MS. SIMS: Do they have anything to run off over there in there too?
REPRESENTATIVE MITCHELL: No. That one was monitored by the state.
MS. SPENCER: State your name.
MS. WOODRUFF: Frances Woodruff. So once all this all is cleaned up, what is being recommended that be replaced, to be replaced, who has the say?
MS. BENNETT: Well, the owner of the property has a say, but he is working with Mr. Mitchell on --

the Mosaic Company.
REPRESENTATIVE MITCHELL: If you can follow the arrow right here (indicating), this is the Arkwright dump site and this is the fertilizer -- here is the railroad track. And that's North Street. This is the entire fertilizer plant site. That's the Arkwright dump site. The state sent in the EPA. They finished this. This is capped. This is what we are talking about, this area back here. This, going back, is the old textile mill, which has a cleanup and restrictions on it.
These two sites were the two Superfund caliber sites here with those restrictions (indicating), they can't do anything, Ms. Jarman, right, as far as any kind of structures on this facility?
MS. JARMAN: That's correct.
REPRESENTATIVE MITCHELL: Now, remember back during that time we talked about some potential reuses? At that time Councilman Reeder was on the council, we had talked about parks. Right now you can't maintain a park the size of, you know, an acre. This is forty-seven acres here. Thirty acres -- you know, the combined acreage, there is no way that the city or the county is going to maintain

something like that in a park. You can't put any kinds of structures on it. So what we had looked at maybe five years ago now, going up to it, was now Rhodia is Solvay. Solvay Chemicals is in here now. The two that we were looking at, and I think you can see -- on page four, you can see those on the document here. The IMC site, you can see those towers that are the Duke Energy towers that are on the site, right here (indicating), what we had looked at and talked about was, in talking with Duke Energy, was developing a solar farm combining both of the sites. And this is something that we are currently -- had a talk back with -- we had those meetings back in the end of 2013 with the EPA, DHEC, Duke Energy, Grow Solar that actually develops these solar farms, and looking at the two sites combined of being able to create the solar farm.

The thing that had our utility company, Duke Energy, concerned at one point was that we didn't have a bill, a legislation in the state, like North Carolina, to get the tax credits. This year we just got that passed, so that changes things for -- you know, as far as Duke Energy is concerned, they are trying to look at creating some pilots for solar farms like SC&G has done in the lower part of

the state. So this is an attraction for them, because of the City of Spartanburg, a company that's at the table. So it's attractive to them to develop, you know, this potential solar farm that can tie into their lines and sell that energy back to Duke.

Now, the benefit out of that, that's part of what is being worked on now. If you look -- and that was one of things that Mosaic had stated and Ed Memmott, City Manager, making sure that there was -- you know, the solar farms would not impact the cap and what they have already completed on the cleanup of the Arkwright dump.

Grow Solar is a company that has actually developed solar farms on landfills and have done it in North Carolina. But what we are looking at, since this is a newly capped landfill, is making sure that there is not an impact and the settling. But with the technology that Grow Solar, what they have put on some other solar farms and we are seeing in some other areas is seeing if it can be done here and that fertilizer plant site and generate -- you know, the whole talk is seeing how -- you know, being able to generate a productive use that could create some kind of revenue and a revenue stream

back for the community. Because you remember, in the beginning, Regenesis was created of the Arkwright community and Forest Park community, both of which now have their 501(c)(3)s. And so this is something that the owner of the solar farm, in selling that energy back, would be able to, to both those nonprofits have some kind of compensation, the stream being able to go to two nonprofits that would benefit from the actual solar farm, itself. So that is a potential, as far as on the reuse, that would keep people off the site, because this site is already fenced in. There is a partial fence around here and on the top part. But the thing is is to keep people off of that site and making sure, as some of the comments that have come in before, no one wants to see another industrial facility come back in there.

What kind of benefit could -- what is the best benefit to the community at this point? And that's where, right now, looking at the potential of a solar farm. So that's where we are with the regulatory agencies, the utility and the property owners, both the City of Spartanburg and Mosaic at this point.

MS. WOODRUFF: Frances Woodruff. What, besides

that solar, would be equivalent to placing something else there?

REPRESENTATIVE MITCHELL: Well, as I stated, you can't put any structures. And when you look at the only -- it's like recreational reuse, who is going to maintain it? And we see where we are right now with the county, they have already identified their projects for parks. What's in the county right now on this side, you have both the 295 complex with the soccer fields. And what the Housing Authority in Spartanburg County is looking at on this Page property down there on Sims Chapel, right now that's the whole point, to try to, you know, build that park in this community here. And you see how long that has taken for that two acres -- two acres, to build that park. So thirty acres --

MS. WOODRUFF: I'm saying like a plant like Solvay, no plants like that could just come in there?

REPRESENTATIVE MITCHELL: And that's why, with those restrictions -- like the restriction on the North Street dump and the Arkwright Mill, it as both of that on there, as far as residential use.

MS. WOODRUFF: Is all that in this pamphlet,

Page 38

the restrictions and stuff?
MS. SPENCER: No. That's what she was talking about earlier. When she said there were deed restrictions on what you could and could not do with the property, that's what she was talking about earlier.
MS. WOODRUFF: I heard that part, but it didn't specify what could and what couldn't and what was restricted and what wasn't.
MS. JARMAN: They are not in place yet, at IMC yet.
MS. SPENCER: Yeah. They are not in place yet. But she gave an example of what would be on the deed restrictions.
MS. WOODRUFF: Because I recognize Solvay, and before we knew anything, it was there, and so we don't want that to happen again.
MS. SPENCER: You're saying you don't want something industrial, another industrial structure.
MS. WOODRUFF: True that.
REPRESENTATIVE MITCHELL: And Solvay, because of the zoning, zoning restrictions in here, when that was proposed, it was nothing, and it wasn't even on the radar screen. But you remember, they told the residents that they were going to be

Page 39

apartment complexes. And there was no zoning, no one said anything, and the next thing you know that chemical storage facility became GAF Chemicals, the chemical storage they started in there first. And that permit kept going down there.
Well, can I answer her question? She said it was still not zoned, that's the problem in Spartanburg County and some of the other places, nobody wants zoning. They don't anybody to tell them what to do. It's just like the people in Fairmont, they didn't want zoning, but you ended up with the Palmetto Landfill. Remember when they stopped the race track from coming in there? They stopped the race track, but they didn't want zoning. You can't have both. If it's open zoning, I mean, you can put whatever as long as, you know, no one shows up and protests for the use. Just like you see a lot of your adult entertainment clubs up there -- I said "entertainment" because I didn't want to say strip clubs.
MS. WOODRUFF: I thought you were going to say you owned one of them.
REPRESENTATIVE MITCHELL: Is that right, Councilman Reeder?
COUNCILMAN REEDER: That's true. But as long

Page 40

as the city, we are in charge of that landfill fence around there, there will be no structure on there, because no structure can go on there. Because you cannot impact the ceiling that's there that will come in there, and then we are back in the same situation of going back and doing a cleanup.
REPRESENTATIVE MITCHELL: In fact, if you look at Fairforest Creek right here, everything on this side of the creek is in the county. Look what's on this side. And if you go to the other side, do you see those facilities within the city? No. There are restrictions. That's why you can't get people to understand that they want to stop things, but they about want zoning, because it's like you can't tell me what to do in my yard.
MS. WOODRUFF: They do that anyway. They do that anyway.
REPRESENTATIVE MITCHELL: This whole thing about zoning restrictions, when that whole thing came up and they said that they didn't want zoning, we don't want anybody telling us what to do, that's when you ended up with GAF. Because remember, the Arkwright, Fuller Acres Community, there was a restrictive covenant on those properties back to that subdivision. But, you know, for the zoning

Page 41

purpose there is no zoning. When the folks said that they were going to build the apartments and they flipped and came in with a chemical storage, they were able to do that because there were no restrictions there.
MS. WOODRUFF: Okay. Like the property that's before the railroad track that has been cleared away coming down North Street, if they wanted to put some kind of plant or something out in that area --
REPRESENTATIVE MITCHELL: You're talking about that's Mount Vernon, on top of the hill?
MS. WOODRUFF: Across from that.
REPRESENTATIVE MITCHELL: I mean, there is still no zoning out there. But what did they do? They haven't been able to get anybody attractive to come back to the property.
MS. WOODRUFF: So that property goes out to Mount Vernon.
REPRESENTATIVE MITCHELL: Mount Vernon. And what they basically did, they cleared out all the trees here. And as you can see, the owner of the property here did the same thing (indicating). And they did it just going around the corner.
A lot folks that are out of state that are purchasing a lot of these properties, are, you know,

cutting for the timber, they are making money off of these properties we see in here. That has been kind of --

MS. WOODRUFF: So nobody owns that?

REPRESENTATIVE MITCHELL: Yes. The owner that owns it, he had has been paying taxes on it and he can't do anything with it. So they were trying to look at some kind of way of recouping some money off of that site, so they started cutting the timber on the front side and down the side of that of Mount Vernon Mills.

MS. WOODRUFF: So we can really look for anything up there.

REPRESENTATIVE MITCHELL: You know -- I mean, we have regulatory agencies here. If someone applies to put something together, wouldn't there be a permitting period process that folks can comment on? Because they can't grandfather that existing permit from that facility, can they?

MS. JARMAN: I'm not really sure about the public commenting on, say, like industrial plants and stuff like that. I can't say. I don't know.

REPRESENTATIVE MITCHELL: But they just can't --

MS. JARMAN: Of course the county office would

have some say for that also.

MS. WOODRUFF: So would it be publicized?

REPRESENTATIVE MITCHELL: Yes. And that has been the problem with Mount Vernon, is that they haven't been able to get anybody in because of what has taken place in that area. The owners had said before that they know that this community is not going to welcome that, so that has been a problem. And then with the hospital on North Street, with those new duplexes that they built there, they know that they are going to have an outcry from the people in there. So that's why they have had problems and troubles with getting someone attractive to come in there.

MS. WOODRUFF: There is a rumor that Housing Authority buying all that property back there and clearing it out.

MS. SPENCER: Do we have any more questions concerning the IMC site? Refocus.

MS. REEDER: I do have just one final one, and I will be finished with it. With our representative and councilman who have followed this, for those of us who are not as informed, is alternative number 2 one that you would embrace?

REPRESENTATIVE MITCHELL: Listening to her,

going back to it, they did a removal back in 2002, and in 2014 we are still at the same state. So looking at what they are talking about, if they do another removal, as she stated, it will be thirty years of looking at the pH in the soils to clear, compared to digging those trenches and putting those --

MS. BENNETT: Solutions.

REPRESENTATIVE MITCHELL: -- solutions in there, sodium carbonate or whatever the solutions that you would inject, it would end up raising those pH levels at a faster rate than what we are talking about that impact the last piece of that area there on the site. So that's why I say -- I was asking you questions and saying that, you know, five million dollars to remove everything and you're going to still end up probably with the same thing and a longer rate for that pH to raise, correct, Ms. Giezelle?

MS. BENNETT: Correct.

MS. REEDER: Is that your guess?

REPRESENTATIVE MITCHELL: Yes.

MS. WOODRUFF: Whenever they get ready to come in and do this cleanup, is there going to be any threat to the neighbors or any harm to us, harm

coming?

MS. BENNETT: That was one of the criteria. That's called short-term effectiveness. And no, there won't be any. They will have the trucks that will come in with the excavation equipment and that kind of thing.

MS. WOODRUFF: I mean, is that not going to stir up a lot of dust and dirt?

MS. BENNETT: No. They will have requirements for that. If it's a dry, windy day, they will have to wet down the soil so it doesn't have any dust or anything. And that would be a requirement.

REPRESENTATIVE MITCHELL: And that was done in the past when the community -- that comment period, that's where Mosaic, when they put that tent around the facility and the water trucks and dug those trenches around the facility and made sure none of the runoff ran into Fairforest Creek, that's the way they did that back then, so they have been consistent, over time, of making sure that that was done properly, where it didn't blow off into the neighborhood.

MS. WOODRUFF: We had quite a big dust storm going through when they, you know, brought the soil down and dumped it. You know, when they put the

Page 46

dirt down there.
REPRESENTATIVE MITCHELL: That was capping a landfill.
MS. WOODRUFF: That's what I'm saying.
REPRESENTATIVE MITCHELL: But I'm saying this is Mosaic. That's not Mosaic. I mean, when they were doing the landfill and you are excavating dirt prior to capping that landfill.
MS. WOODRUFF: Right.
COUNCILMAN REEDER: And that was not harmful.
REPRESENTATIVE MITCHELL: That wasn't contaminated.
COUNCILMAN REEDER: That wasn't contaminated.
MS. WOODRUFF: I'm saying, what they bringing is harmful going on there.
MS. SPENCER: And in this particular situation they are just digging a trench. They won't be taking soil through the neighborhood. They are digging a trench on site.
MR. CASSIDY: Of the alternatives presented, the impact on the community is going to be minimal. But it's going to be most minimal with that alternative, compared to the other two alternatives. You know, there would be a lot more potential to see some effect with the other alternatives.

Page 47

MS. REEDER: What is the duration?
MS. BENNETT: It's just an estimate, but they are thinking that it will be like fifteen years. But as far as active remediation, it probably will be, what, three to four years, Dan? That's the Mosaic contractor.
MR. MADISON: Well, the actual excavations will be very quickly when we put the pipe in. And then there will be a couple years of periodically adding more solution to the trenches.
MS. JARMAN: She wants to know the time period of construction, how long will the construction be?
MR. MADISON: Construction? I can't say off the top of my head, but we are talking about, you know --
MS. BENNETT: Three months, at the most?
MR. MADISON: Yes.
MS. SPENCER: State your name, Dan.
MR. MADISON: Dan Madison.
MS. SPENCER: Did that answer your question, Ms. Reeder?
MS. REEDER: Yes.
MS. SPENCER: Any other questions?
If there aren't any more questions, but if you think of something afterwards, in the proposed

Page 48

plan there is a sheet in the back. If you want to write your comment or question on that sheet and mail it to Giezelle, or you can send it e-mail. If you have e-mail, you can send your e-mail to Giezelle. You can do it afterwards, if you think about it, or if you think of a question afterwards.
Or if you think of something and you don't have an e-mail, my information -- call me. I will type it up for you and put your name on it and give it to Giezelle. Otherwise, thank you all for coming out tonight. We appreciate your participation and your interest in the site. And if you have any questions, again, Giezelle's information, as well as mine, is in the proposed plan fact sheet. Thank you.
(IMC Proposed Plan Public Meeting Concluded At 7:30 P.M.)

Page 49

CERTIFICATE

I, the undersigned, Elaine L. Grove-DeFreitas, RPR, Notary Public, in and for the State of South Carolina, do hereby certify that the foregoing IMC Site Public Meeting was taken on the 26th day of June 2014.

That the foregoing is an accurate transcription of the proceedings.

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 30th day of June 2014.

Elaine L. Grove-DeFreitas, RPR
Notary Public for South Carolina
My Commission Expires: 6-25-2020

CERTIFICATE

I, the undersigned, Elaine L. Grove-DeFreitas, RPR, Notary Public, in and for the State of South Carolina, do hereby certify that the foregoing IMC Site Public Meeting was taken on the 26th day of June 2014.

That the foregoing is an accurate transcription of the proceedings.

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 30th day of June 2014.

Elaine L. Grove-DeFreitas, RPR
Notary Public for South Carolina
My Commission Expires: 6-25-2020

APPENDIX C
ADMINISTRATIVE RECORD INDEX

[Draft]

Administrative Record Index
for the
INTERNATIONAL MINERALS AND CHEMICALS (IMC) SITE

SCD003350493

1.0 PRE-REMEDIAL

1. 9 Site Inspection Documents

1. "Final Site Inspection Report, International Minerals and Chemical Corp. (IMC), Spartanburg, Spartanburg County, South Carolina, Revision 1," Tetra Tech EM, Inc. (March 22, 1999)

1.10 Expanded Site Inspection Documents

1. "Expanded Site Inspection Report, International Minerals and Chemical Corp., Spartanburg, Spartanburg County, South Carolina, Revision 1," Tetra Tech EM Inc. (November 16, 2000)

2.0 REMOVAL RESPONSE

2. 1 Correspondence

1. Letter from Greg Cassidy and Kayse Jarman, South Carolina Department of Health and Environmental Control (SCDHEC) to Giezelle S. Bennett, USEPA Region IV. Providing the SCDHEC's concurrence with the current version of the Action Memorandum for the IMC Fertilizer Site. (March 31, 2009)

2. Cross-Reference: "Responsiveness Summary, International Minerals and Chemicals (IMC) Site, Spartanburg, Spartanburg County, South Carolina," USEPA Region IV. (September 30, 2009) [Filed and cited in entry 2.9 REMOVAL RESPONSE - Action Memoranda].

3. Email from Greg Cassidy, SCDHEC to Addressees. Subject: IMC. (10:39 AM). (December 02, 2009)

4. Email from Greg Cassidy, SCDHEC to Addressees (with attachment). Subject: IMC NTCRA Work Plan Solid Waste ARARs. (04:46 PM). (December 09, 2009)

5. Letter from Debra Waters, The Mosaic Company to Giezelle Bennett, USEPA (with attachment). Regarding Mosiac's Workplan for the non-time critical removal action planned for the Site. (January 14, 2010)

6. Letter from Giezelle Bennett, USEPA to Debra Waters, The Mosaic Company. Regarding EPA and SCDHEC's approval of the May 7, 2010 Non-Time Critical Removal Action (NTCRA) Workplan. (May 20, 2010)

7. Email from Giezelle Bennett, USEPA to Addressees (with attachment). Subject: FW: IMC submittals. (1:00 PM). (November 04, 2010)

8. Letter from Giezelle Bennett, USEPA to Jim Brandt, Mosaic Company. Subject: Notice of Completion of Work, International Mineral & Chemical (IMC) Site, Spartanburg, SC. (August 08, 2011)

2. 2 Sampling and Analysis Data

1. Letter from Dan O. Madison, TRC Solutions to Giezelle Bennett, USEPA (with attachment). Subject: Analytical results for May 2011 Semiannual Groundwater Monitoring Event, Former IMC Fertilizer Site, Spartanburg, South Carolina. (June 23, 2011)

2. 4 Work Plans and Progress Reports

1. "Non-Time Critical Removal Action (NTCRA) Workplan and Design Report, Former IMC Fertilizer Site, Spartanburg, South Carolina," RMT. (October 2009)

[Draft]

Administrative Record Index
for the
INTERNATIONAL MINERALS AND CHEMICALS (IMC) SITE

2.0 REMOVAL RESPONSE

2. 4 Work Plans and Progress Reports

2. Letter from Robert W. Hanley, RMT to Tina Hadden, USACE. Regarding the Non-Time Critical Removal Action (NTCRA) Workplan and Design Report for the Former IMC Fertilizer Site. (October 12, 2009)

3. Email From Greg Cassidy, SCDHEC to Addressees. Subject: IMC NTCRA Work Plan. (11:34 AM). (October 28, 2009)

4. "Non-Time Critical Removal Action (NTCRA) Workplan and Design Report, Former IMC Fertilizer Site, Spartanburg, South Carolina," RMT. (November 2009)

5. Letter from Greg Cassidy and Kayse Jarman, SCDHEC to Giezelle Bennett, USEPA. Regarding comments for the Non-Time Critical Removal Action (NTCRA) Workplan and Design Report, Dated October 2009. (November 03, 2009)

6. Letter from Giezelle Bennett, USEPA to Debra Waters, The Mosaic Company (with attachment). Providing comments for the Non-Time Critical Removal Action (NTCRA) Workplan and Design Report, Dated October 2009. (November 04, 2009)

7. Letter from Giezelle Bennett, USEPA to Debra Waters, The Mosaic Company (with attachment). Providing comments for the Non-Time Critical Removal Action (NTCRA) Workplan and Design Report. (February 09, 2010)

8. Letter from Dan O. Madison, RMT to Giezelle Bennett, USEPA (with attachment). Providing responses to comments for the Non-Time Critical Removal Action (NTCRA) Workplan and Design Report. (March 05, 2010)

9. Letter from Greg Cassidy, SCDHEC to Giezelle Bennett, USEPA. Regarding comments for the Non-Time Critical Removal Action (NTCRA) Workplan and Design Report, dated March 5, 2010. (April 19, 2010)

10. "Non-Time Critical Removal Action (NTCRA) Workplan and Design Report, Former IMC Fertilizer Site, Spartanburg, South Carolina," RMT. (May 2010)

11. Letter from Debra Waters, The Mosaic Company to Giezelle Bennett, USEPA. Regarding USEPA and SCDHEC review comments on the Non-Time Critical Removal Action (NTCRA) Workplan and Design Report for the Former IMC Fertilizer Site. (May 03, 2010)

2. 8 Removal Response Reports

1. Letter from Karen Saucier, RMT to William Joyner, USEPA (with attachment). Providing the Revised Focused Removal Action Workplan for the Former IMC Fertilizer Site in Spartanburg, South Carolina. (July 17, 2002)

2. "Non-Time Critical Removal Action (NTCRA) Report, Former IMC Fertilizer Site, Spartanburg, South Carolina, May 2011, Revised June 2011, Appendix D - Manifests [Part 1 of 2]," [2 of 3], RMT, Inc. (June 01, 2011)

3. "Non-Time Critical Removal Action (NTCRA) Report, Former IMC Fertilizer Site, Spartanburg, South Carolina, May 2011, Revised June 2011, Appendix D - Manifests [Part 2 of 2]," [3 of 3], RMT, Inc. (June 01, 2011)

4. "Non-Time Critical Removal Action (NTCRA) Report, Former IMC Fertilizer Site, Spartanburg, South Carolina, May 2011, Revised June 2011," [1 of 3], RMT, Inc. (June 01, 2011)

[Draft]

Administrative Record Index
for the
INTERNATIONAL MINERALS AND CHEMICALS (IMC) SITE

2.0 REMOVAL RESPONSE

2. 9 Action Memoranda

1. Action Memorandum from Giezelle S. Bennett, USEPA Region IV to Franklin E. Hill, USEPA Region IV. Regarding the request for and documentation of the proposed non-time-critical removal action (NTCRA) to address contaminated soil and process residuals at the International Mineral and Chemical Corporation (IMC) Fertilizer Site, Spartanburg, Spartanburg County, South Carolina. (September 30, 2009) [Includes the Responsiveness Summary] [Note: Due to the CONFIDENTIAL nature, a portion of this document has been withheld. Withheld material is available for, Judicial review only, at EPA Region IV, Atlanta, Georgia.].

2. Revised Enforcement Action Memorandum from Giezelle S. Bennett, USEPA Region IV to Franklin E. Hill, USEPA Region IV. Regarding a Change in Scope at the International Mineral and Chemical (IMC) Site, Spartanburg, Spartanburg County, South Carolina. (June 01, 2010)

3.0 REMEDIAL INVESTIGATION (RI)

3. 1 Correspondence

1. Letter from Giezelle Bennett, EPA Region IV to James Van Nortwick, Vigindustries, Inc. Stating that the May 5, 2004 replacement pages for the Remedial Investigation/Feasibility Study (RI/FS) Workplan were acceptable and the RI/FS workplan and associated documents dated May 2004 are approved. (May 11, 2004)

2. Letter from Dan Madison, RMT Integrated Environmental Solutions to Giezelle Bennett, EPA Region IV. Regarding the schedule for RI Field Activities at the IMC Fertilizer Site North Street Extension, Spartanburg, South Carolina. (May 17, 2004)

3. Letter from Dan Madison, RMT Integrated Environmental Solutions to Giezelle Bennett, EPA Region IV (with attachment). Regarding Supplemental Sampling of Wastewater/Process Residuals. (June 15, 2005)

4. Letter from Dan Madison and Karen Saucier, RMT, Inc. to Giezelle Bennett, EPA Region IV (with attachments). Regarding Supplemental Sampling of Wastewater/Process Residuals for the former IMC Fertilizer Site, Spartanburg, South Carolina. (August 31, 2005)

5. Letter from Dan Madison and Karen Saucier, RMT, Inc. to Giezelle Bennett, EPA Region IV (with attachments). Regarding the Revised Supplemental Remedial Investigation (RI) Workplan for the former IMC Superfund Site, Spartanburg, South Carolina. (February 22, 2006)

6. Letter from Dan Madison and Karen Saucier, RMT, Inc. to Giezelle Bennett, EPA Region IV (with attachments). Regarding Phase II Supplemental Remedial Investigation (RI) Work Scope for the former IMC Superfund Site, Spartanburg, South Carolina. (August 10, 2006)

7. Letter from Giezelle Bennett, EPA Region IV to Karen Saucier, RMT, Inc. Stating that the Phase II Supplemental Remedial Investigation (RI) Work Scope dated August 10, 2006 is approved. (August 18, 2006)

8. Letter from Dan Madison, RMT, Inc to Giezelle Bennett, EPA Region IV. Regarding the location for monitoring well MW-15 in the Phase II Supplemental RI Work Scope. (August 23, 2006)

9. Letter from Don Rigger, EPA Region IV to Keith Lindler, SCDHEC. Memorializing agreements reached between EPA and SCDHEC during the December 5, 2006 conference call. (December 22, 2006)

[Draft]

Administrative Record Index
for the
INTERNATIONAL MINERALS AND CHEMICALS (IMC) SITE

3.0 REMEDIAL INVESTIGATION (RI)

3. 1 Correspondence

10. Letter from Donald Siron and Harriet Gilkerson, SCDHEC to Debra Waters, The Mosaic Company. Regarding response to January 3, 2007 letter outlining Mosaic's position on six additional sampling actions the Department had requested. (January 12, 2007)

11. Letter from Dan Madison, RMT, Inc to Giezelle Bennett, EPA Region IV (with attachments). Regarding workplan to assess the geophysical anomaly. (February 13, 2007)

12. Letter from Dan Madison, RMT, Inc to Giezelle Bennett, EPA Region IV. Regarding the request to abandon monitoring well MW-15. (April 11, 2007)

13. Letter from Giezelle Bennett, EPA Region IV to Dan Madison, RMT, Inc. Stating that the request of April 11, 2007 to abandon monitoring well MW-15 is approved. (April 13, 2007)

14. Letter from Giezelle Bennett, EPA Region IV to Debra Waters, The Mosaic Company. Stating that the Remedial Investigation (RI) Report for the IMC Superfund Site dated April 2007 is approved with stipulations. (May 24, 2007)

15. Letter from Dan Madison and Karen Saucier, RMT, Inc. to Giezelle Bennett, EPA Region IV (with attachments). Regarding the summary of assessment activities with a geophysical anomaly identified near the southern property line of the Former IMC Fertilizer Site. (June 06, 2007)

16. Email from Dan Madison, RMT, Inc. to Giezelle Bennett, EPA Region IV. Regarding Proposed clean up levels to be used in the Action Memorandum for the Former IMC Fertilizer site. (January 19, 2009)

17. Meeting Summary - Reuse of Formerly Contaminated Properties in Spartanburg, SC. (November 12, 2013)

18. Email from Cynthia Peurifoy, USEPA to Addressees (with attachment). Subject: RE: Spartanburg Redevelopment Meeting Notes. (12:13 PM). (December 04, 2013)

19. Email from Dan Madison, TRC Solutions to Giezelle Bennett, USEPA. Subject: RE: December 17, 2013 Spartanburg Meeting. (2:58 PM). (January 06, 2014)

20. Email from Tim Heinle, Gro Solar to Addressees. Subject: RE: December 17, 2013 Spartanburg Meeting. (10:13 AM). (January 06, 2014)

21. Email from Giezelle Bennett, USEPA to Addressees (with attachment). Subject: December 17, 2013 Meeting Notes. (1:46 PM). (January 15, 2014)

22. Email from Tim Heinle, Gro Solar to Addressees. Subject: RE: December 17, 2013 Meeting Notes. (6:34 PM). (January 15, 2014)

23. Email from Cynthia Peurifoy, USEPA to Addressees. Subject: Fwd: Duke Energy's interest in Solar Farm at Arkwright Superfund Sites. (4:41 PM). (February 24, 2014)

24. Letter from Franklin E. Hill, USEPA to Harold Mitchell, ReGenesis. Subject: Support for renewable energy development on the Arkwright Dump and International Mineral and Chemical (IMC) Superfund Sites. (March 21, 2014)

[Draft]

Administrative Record Index
for the
INTERNATIONAL MINERALS AND CHEMICALS (IMC) SITE

3.0 REMEDIAL INVESTIGATION (RI)

3. 2 Sampling and Analysis Data

1. Memorandum from Rick Gillam, EPA Region IV to Bill Joyner, EPA Region IV. Regarding the Preliminary Air Modeling for International Materials and Chemical (IMC) Corp. Superfund Site located in Spartanburg, South Carolina. (November 08, 2001)

2. Letter from Dan Madison, RMT, Inc. to Giezelle Bennett, EPA Region IV (with attachments). Regarding grid locations selected for laboratory analysis. (July 15, 2004)

3. Letter from Dan O. Madison, RMT Integrated Environmental Solutions to Giezelle Bennett, EPA Region IV (with attachments). Regarding the proposed analytical parameters and second round groundwater samples at the IMC Fertilizer Site North Street Extension, Spartanburg, South Carolina. (July 28, 2004)

4. Memorandum from Brian Striggow, EPA Region IV to Giezelle Bennett, EPA Region IV (with attachments). Regarding temporary well sampling associated with IMC Fertilizer SESD Project #07-0339. (April 04, 2007)

5. Letter from Judy Canova, South Carolina Department of Health and Environmental Control (SCDHEC) to Giezelle Bennett, EPA Region IV (with attachment). Regarding the IMC Sampling Trip Report for May 15, 2007 and May 16, 2007. (June 11, 2007)

6. Memorandum from Brian Striggow, EPA Region IV to Giezelle Bennett, EPA Region IV. Regarding the results of the temporary well sampling associated with IMC Fertilizer SESD Project #07-0339. (June 14, 2007)

7. Letter from Dan Madison, RMT to Reginald E. Robinson, South Carolina Department of Health and Environmental Control (with attachment). Regarding comments on SCDHEC's Former IMC Fertilizer Site Sampling Trip Report. (June 19, 2007)

8. Technical Memorandum from Dan Madison, RMT to Giezelle Bennett, EPA Region IV (with attachments). Regarding SCDHEC Stream Sampling Event, May 15-16, 2007. (June 19, 2007)

9. Technical Memorandum from Dan Madison, RMT to Giezelle Bennett, EPA Region IV (with attachments). Regarding analytical results for groundwater sample splits collected from temporary wells at the Former IMC Fertilizer Site, Spartanburg, South Carolina. (July 02, 2007)

10. Letter from Dan O. Madison, TRC Solutions to Giezelle Bennett, USEPA (with attachment). Subject: Analytical results for October/November 2011 Semiannual Groundwater Monitoring Event, Former IMC Fertilizer Site, Spartanburg, South Carolina. (February 06, 2012)

11. Letter from Dan O. Madison, TRC Solutions to Giezelle Bennett, USEPA (with attachment). Subject: Analytical results for May 2012 Semiannual Groundwater Monitoring Event, Former IMC Fertilizer Site, Spartanburg, South Carolina. (July 31, 2012)

12. Letter from Dan O. Madison, TRC Solutions to Giezelle Bennett, USEPA (with attachment). Subject: Analytical results for November 2012 Semiannual Groundwater Monitoring Event, Former IMC Fertilizer Site, Spartanburg, South Carolina. (January 22, 2013)

13. Email from Dan Madison, TRC Solutions to Giezelle Bennett, USEPA (with attachments). Subject: FW: Updated Risks Support Tables - IMC. (9:09 am). (July 07, 2014)

14. Email from Dan Madison, TRC Solutions to Giezelle Bennett, USEPA (with attachment). Subject: RE: IMC. (5:05 pm). (July 11, 2014)

[Draft]

Administrative Record Index
for the
INTERNATIONAL MINERALS AND CHEMICALS (IMC) SITE

3.0 REMEDIAL INVESTIGATION (RI)

3. 4 Work Plans and Progress Reports

1. "Remedial Investigation and Feasibility Study (RI/FS) Workplan, IMC Fertilizer Site, Spartanburg, South Carolina," RMT, Inc. (May 2004) [Contains May 2003 Focused Removal Report, Volume 1 of 2 as attachment H].

2. Letter from Dan Madison and Karen Saucier, RMT, Inc. to Giezelle Bennett, EPA Region IV (with attachments). Regarding the proposed Supplemental Remedial Investigation (RI) Workplan at the Former IMC Superfund Site, Spartanburg, South Carolina. (December 16, 2005)

3. Technical Memorandum from Dan Madison and Karen Saucier, RMT, Inc. to Giezelle Bennett, EPA Region IV (with attachments). Regarding the Supplemental Remedial Investigation (RI) Workplan. (July 14, 2006)

3. 7 Applicable or Relevant and Appropriate Requirements (ARARs)

1. Letter from Giezelle Bennett, EPA Region IV to Reginald Robinson, SCDHEC. Regarding a request for identification of State of South Carolina Applicable or Relevant and Appropriate Requirements (ARARs) that pertain to the International Mineral and Chemical Corp. (IMC) Superfund Site located in Spartanburg, South Carolina. (April 25, 2007)

2. Letter from Harriet Gilkerson, SCDHEC to Giezelle Bennett, EPA Region IV (with attachment). Providing a response to the request for identification of State of South Carolina Applicable or Relevant and Appropriate Requirements (ARARs) that pertain to the International Mineral and Chemical Corp. (IMC) Superfund Site located in Spartanburg, South Carolina. (May 15, 2007)

3. 8 Interim Deliverables

1. "Focused Removal Report, Former IMC Fertilizer Site, Spartanburg, South Carolina, Volume 2 of 2," RMT, Inc. (May 2003) [Note: This document, comprised of sampling and analysis data, is not included in the Administrative Record but may be reviewed, by appointment only, at EPA Region IV, Atlanta, Georgia.].

2. Cross-Reference: "Focused Removal Report, Former IMC Fertilizer Site, Spartanburg, South Carolina, Volume 1 of 2," RMT, Inc. (May 2003) [Filed and cited in Appendix H - Focused Removal Report as entry 1 in 3.4 REMEDIAL INVESTIGATION (RI) - Work Plans and Progress Reports].

3. "Refinement of Ecological Chemicals of Potential Concern, Former IMC Fertilizer Site, Spartanburg County, South Carolina," RMT, Inc. (August 2003)

4. "Remedial Investigation and Feasibility Study Health & Safety Plan, IMC Fertilizer Site, Spartanburg, South Carolina," RMT, Inc. (October 2003)

5. "Remedial Investigation and Feasibility Study Sampling and Analysis Plans, IMC Fertilizer Site, Spartanburg, South Carolina," RMT, Inc. (May 2004)

3.10 Remedial Investigation (RI) Reports

1. "Remedial Investigation (RI) Report, Former IMC Fertilizer Site, Spartanburg, South Carolina, Volume 1 of 2," RMT, Inc. (April 2007)

[Draft]

Administrative Record Index
for the
INTERNATIONAL MINERALS AND CHEMICALS (IMC) SITE

3.0 REMEDIAL INVESTIGATION (RI)

3.10 Remedial Investigation (RI) Reports

2. "Remedial Investigation (RI) Report, Former IMC Fertilizer Site, Spartanburg, South Carolina, Volume 2 of 2," RMT, Inc. (April 2007) [Note: A portion of this document, comprised of sampling and analysis data, is not included in the Administrative Record but may be reviewed, by appointment only, at EPA Region IV, Atlanta, Georgia.].

3.11 Health Assessments

1. "Health Consultation, International Minerals and Chemical, Spartanburg, Spartanburg County, South Carolina," Agency for Toxic Substances and Disease Registry (ATSDR). (November 08, 1999)

3.12 Endangerment Assessments

1. "Screening Level Ecological Risk Assessment, IMC Fertilizer Site, Spartanburg, South Carolina," RMT Integrated Environmental Solutions. (March 2002)
2. Letter from Karen Saucier, RMT Integrated Environmental Solutions to William Joyner, EPA Region IV (with attachment). Regarding responses to the technical review comments provided by the USEPA on the revised screening level ecological risk assessment. (March 26, 2002)

4.0 FEASIBILITY STUDY (FS)

4. 1 Correspondence

1. Letter from Dan O. Madison, TRC Environmental Corporation to Giezelle Bennett, USEPA. Subject: Request for extension for submittal of responses to Agency review comments dated December 5, 2013, Focused Feasibility Study For Groundwater. (January 06, 2014)
2. Letter from Giezelle Bennett, USEPA to Jim Brandt, Mosaic. Subject: Approval of the Focused Feasibility Study (FFS) Report, IMC Superfund Site, Spartanburg, SC. (June 02, 2014)

4. 2 Sampling and Analysis Data

1. Email from Dan Madison, TRC Solutions to Giezelle Bennett, USEPA (with attachments). Subject: FW: Replacement Pages for IMC FFS Report. (9:09 am). (July 14, 2014)

4. 9 Feasibility Study (FS) Reports

1. "Feasibility Study (FS) Report, Former IMC Fertilizer Site, Spartanburg, South Carolina," RMT, Inc. (February 2008)
2. "Focused Feasibility Study (FFS) Report Former IMC Fertilizer Sitem Spartanburg, South Carolina, July 2013, Revised March 2014 and May 2014," TRC Solutions. (May 2014)

4.10 Proposed Plans for Selected Remedial Action

1. "EPA Proposes Action on International Mineral & Chemical (IMC) Site, Spartanburg, South Carolina," EPA Region IV. (May 2009)
2. "Superfund Proposed Plan Fact Sheet, International Mineral & Chemical (IMC) Site, Spartanburg, South Carolina," EPA Region IV. (June 2014)

[Draft]

Administrative Record Index
for the
INTERNATIONAL MINERALS AND CHEMICALS (IMC) SITE

7.0 REMEDIAL ACTION (RA)

7. 8 Remedial Action Documents

1. Letter from Willie Morgan, SCDHEC to John Dickinson, EPA Region IV (with attachment). Providing a copy of the Closure Plan for International Minerals & Chemical Corporation, Spartanburg, South Carolina. (August 14, 1986)

9.0 STATE COORDINATION

9. 3 EPA/State Contracts

1. "Clean Water Act Section 404 Joint Federal and State Application, Former IMC Fertilizer Site, Spartanburg County, South Carolina," RMT. (October 2009)

10.0 ENFORCEMENT

10.11 EPA Administrative Orders

1. Administrative Order on Consent for Remedial Investigation/Feasibility Study and Removal Action. In the Matter of: IMC Fertilizer Site, North Street Extension Spartanburg, Spartanburg, SC, Vigindustries Respondent, EPA Docket No. CERCLA-01-3753-C. (July 10, 2001)
2. Administrative Settlement Agreement and Order on Consent for Removal Action, In the Matter of: International Minerals and Chemicals Superfund Alternative Site, Spartanburg, Spartanburg County, South Carolina, Vigindustries, Inc. Respondent, CERCLA Docket No. CERCLA-04-2010-3751 (October 03, 2009)

11.0 POTENTIALLY RESPONSIBLE PARTIES (PRP)

11. 9 PRP-Specific Correspondence

1. Letter from Robert Jourdan, USEPA Region IV to Michael Daneker, Arnold and Porter. Notifying Vigndustries, Inc. of potential liability for remedial investigation/feasibility study (RI/FS) and demand for payment in reference to the IMC Fertilizer Site, Spartanburg, South Carolina. (June 21, 2001)
2. Letter from Rosalind Brown, USEPA to Michael Daneker, International Mineral & Chemical, Inc. (with attachment). Regarding the demand for reimbursement of past costs expended at the IMC Fertilizer Superfund Site. (July 13, 2005) [Note: Due to CONFIDENTIAL nature, a portion of this document has been withheld. Withheld material is available for, Judicial review only, at EPA Region IV, Atlanta, Georgia.].

13.0 COMMUNITY RELATIONS

13. 1 Correspondence

1. Letter from Chuck Claunch, Duke Energy Carolinas to Harold Mitchell, Jr., ReGenesis, Subject: Arkwright Community. (February 25, 2014)

13. 6 Community Relations Plans

1. "Community Involvement Plan, International Minerals and Chemicals Site, Spartanburg, Spartanburg County, South Carolina," Black & Veatch Special Projects Corp. (July 27, 2001)

[Draft]

Administrative Record Index
for the
INTERNATIONAL MINERALS AND CHEMICALS (IMC) SITE

13.0 COMMUNITY RELATIONS

13. 9 Fact Sheets

1. Cross Reference: "Superfund Proposed Plan Fact Sheet, International Mineral & Chemical (IMC) Site, Spartanburg, South Carolina," EPA Region IV. (June 2014) [Filed and cited in Entry Number 2 of 4.10 FEASIBILITY STUDY (FS) - Proposed Plans for Selected Remedial Action]

17.0 SITE MANAGEMENT RECORDS

17. 4 Site Audio-Visuals

1. Letter of transmittal from Dan Madison, RMT, Inc. to Giezelle Bennett, EPA Region IV (with attachments). Regarding photographs of soils from borings that penetrated wastewater/process residuals at the Former IMC Fertilizer Site. (May 26, 2005)